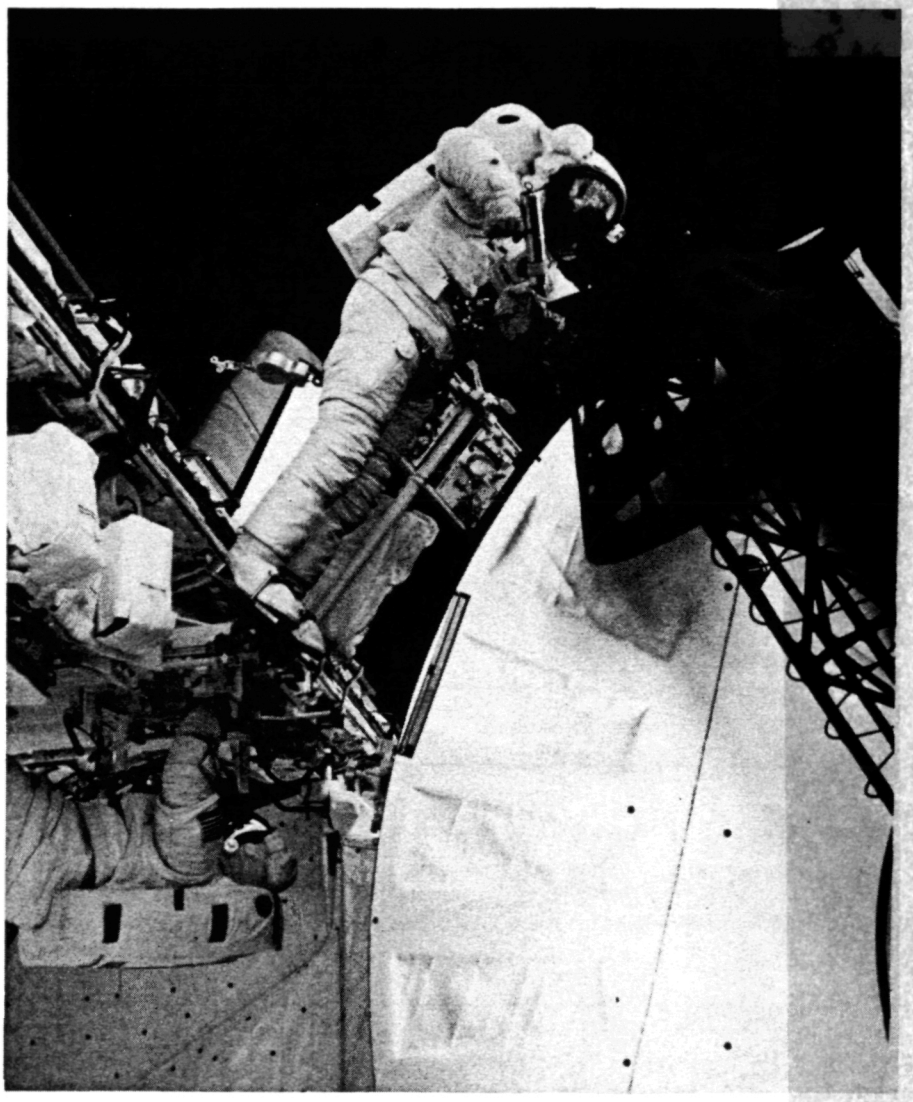
JSC-20466
Rev A

JOHNSON
TM-54-TM
P-493

EVA Catalog
Tools and Equipment



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

N91-71348

Unclas
00/54 0019569

(NASA-TM-104963) EVA CATALOG: TOOLS AND EQUIPMENT. REVISION A (NASA) 493 p

NASA
National Aeronautics and Space Administration

Lyndon B. Johnson Space Center
Houston, Texas

April 1989

JSC-20466
Rev A

EVA CATALOG

Tools and Equipment

April 1989

Book Managers:

Robert C. Trevino
R. C. Trevino
EVA/Crew Systems Section
Mission Operations Directorate

Richard K. Fullerton
R. K. Fullerton
EVA/Crew Systems Section
Mission Operations Directorate

Approved by:

R. T. Neal
R. T. Neal
Head, EVA/Crew Systems Section
Mission Operations Directorate

Richard N. Fitts
R. N. Fitts
Chief, Mechanical and Crew
Systems Branch
Mission Operations Directorate

C. E. Whitsett
C. E. Whitsett
Spec. Asst. for Payloads & Projects
Crew and Thermal Systems Division

Charles T. Woolley
C. T. Woolley
Satellite Services Systems Rep.
New Initiatives Office

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TEXAS

PREFACE

Since the last publication of this document, many new EVA hardware items have been developed and numerous others have been revised. Some of the additions included in the catalog were flown on Space Shuttle missions toward the end of 1985. Many others have been added as part of the tool inventory for maintenance of the Hubble Space Telescope. Data included from the original edition has also been updated and expanded where necessary. Several comments and suggestions from the first edition were incorporated into this revision. The format of the document remains essentially unchanged except for the inclusion of a table of contents and a new appendix listing items by generic categories. An evaluation of each hardware item for recommended EVA use has been included for design and operational information.

Because of the many changes, the previous editions of this catalog (JSC-20466, November 1985, and JSC-19211, September 1983) are now obsolete. As the Space Shuttle program continues into the Space Station Freedom era, further updates will be generated as required. For the time being, this document should serve as an accurate and comprehensive reference source.

A separate document, JSC-22976, Servicing Equipment Catalog, can be referred to for information on payload interface hardware. It complements the EVA catalog, but the EVA catalog is more reliable when conflicting information is presented in the two publications.

Both documents were funded by the NASA Headquarters Office of Space Flight (OSF) Satellite Servicing Branch, code MD, and their support is very much appreciated.

Once again, the assistance of Lockheed Engineering and Management Services Company, Inc., ILC Space Systems, and Omniplan Corporation is greatly appreciated. In addition to those individuals responsible for the success of the original publication, the following contractor support personnel have made this edition possible:

Lockheed Engineering and Management Services Company, Inc.

Herb Patterson
Lana Arnold

ILC Space Systems

Michael Withey
Sarah Early

Omniplan Corporation

Terry Whinery

INTRODUCTION

A wide range of groups should find this document useful in the pursuit of EVA hardware information. Designers can note the construction of recommended items based on existing hardware. Payload customers can take advantage of tools presently in NASA inventory and save the expense of "reinventing the wheel." Crews and flight controllers at JSC can use the information as a basic reference and training guide. Users should be aware that while every reasonable effort has been made to provide accurate data, specific technical information and availability should be obtained from those persons listed as contacts for each item.

Those who wish to design new EVA equipment should refer to Description and Design Requirements-EVA, appendix 7 of NSTS 07700, volume XIV. This document contains guidelines for approved EVA tool design practices and replaces JSC-10615, Space Transportation System EVA Description and Design Criteria.

The catalog contains a mixture of tools and equipment used throughout the Space Shuttle-based EVA program. Promising items which have reached the prototype stage of development are also included. Each item is described with a photo, a written discussion, technical specifications, dimensional drawings, and points of contact for additional information. Numbers on the upper left-hand corner of each photo may be used to order specific pictures from NASA and contractor photo libraries. Points of contact have been classified as either operational, technical, or source. An operational contact is someone familiar with the basic function and on-orbit use of the tool. A technical contact would be the best source of detailed technical specifications and is typically the NASA subsystem manager. A source contact is usually the original supplier or contact for the supplier of an item and may be the same as the technical contact. The technical information table for each item uses the following terms to describe the availability or status of each hardware item:

Standard - Flown on every mission as standard manifest
Flight specific - Certified, in stock, not flown every mission
Reference only - Item no longer available
Developmental - In the prototype stage and not yet certified

The current availability of any flight-specific tool should be verified with the source or technical point of contact. Those tools built for Hubble Space Telescope maintenance are program dedicated and are not readily available to other customers. Other customers can have new tools built from the existing, already certified designs.

Comments or questions regarding the format or content are welcome and may be submitted using the form in appendix A. In addition to the comment form, the appendices show past flight manifesting of EVA hardware for selected missions and the recommended EVA compatibility of each item. Listings of related reference documents and acronyms are also provided.

PAGE ii INTENTIONALLY BLANK
PRECEDING PAGE BLANK NOT FILMED

CONTENTS

Item		Page
	PREFACE	i
	INTRODUCTION	iii
	TOOLS AND EQUIPMENT DESCRIPTIONS	
1	1/2-INCH ALLEN WRENCH FOR 3/8-INCH DRIVE	1-1
2	1/2-INCH DRIVE RATCHET	1-3
3	1/2-INCH OPEN END WRENCH	1-5
4	1/2-INCH RATCHETING BOX END WRENCH	1-7
5	1/4-INCH ALLEN WRENCH EXTENSION FOR 3/8-INCH DRIVE	1-9
6	1/4-INCH ALLEN WRENCH EXTENSION FOR 3/8-INCH DRIVE (IPS)	1-11
7	1/4-INCH CROW'S FOOT WRENCH	1-13
8	1/4-INCH DRILL EXTENSION FOR 3/8-INCH DRIVE	1-15
9	15/16-INCH WRENCH WITH CHEATER BAR	1-17
10	3/8-INCH DRIVE McTETHER RATCHET	3-1
11	3/8-INCH DRIVE RATCHET	3-3
12	3/8-INCH DRIVE RATCHET (SAL)	3-5
13	3/8-INCH DRIVE RATCHET WITH 7/16-INCH HEX SOCKET	3-7
14	3/8-INCH DRIVE RATCHET WITH 7/16-INCH HEX SOCKET EXTENSION	3-9
15	3/8-INCH DRIVE RATCHET, EVA	3-11
16	3/8-INCH DRIVE RATCHET, EVA WITH 7/16-INCH HEX SOCKET	3-13
17	35-mm CAMERA	3-15
18	35-mm CAMERA COVER	3-17
19	35-mm CAMERA MOUNT	3-19
20	5/16-INCH HEX SOCKET FOR 3/8-INCH DRIVE	5-1
21	5/16-INCH HEX SOCKET FOR 3/8-INCH DRIVE (HST)	5-3
22	7/16-INCH AND 1/2-INCH BOX END WRENCH	7-1
23	7/16-INCH HEX SOCKET EXTENSION FOR 3/8-INCH DRIVE	7-3
24	7/16-INCH HEX SOCKET EXTENSION FOR 3/8-INCH DRIVE (HST)	7-5
25	7/16-INCH HEX SOCKET FOR 3/8-INCH DRIVE (HST)	7-7
26	7/16-INCH OPEN END WRENCH	7-9
27	7/16-INCH RATCHETING OPEN END WRENCH	7-11
28	ADJUSTABLE WRENCH	A-1
29	AIRLOCK	A-3
30	AIRLOCK STOWAGE BAG	A-5
31	ANTENNA BRIDGE STRUCTURE	A-7
32	ANTENNA CUTTER	A-9
33	APOGEE KICK MOTOR CAPTURE DEVICE	A-11
34	APOGEE KICK MOTOR NOZZLE COVER	A-13
35	BAG, EVA	B-1
36	BAR STOWAGE ASSEMBLY	B-3
37	BAR, CAPTURE	B-5
38	BAR, GRAPPLE	B-7
39	BAR, HANDLING	B-9
40	BAR, SPIN-UP	B-11
41	BOLT PULLER	B-13

PAGE IV INTENTIONALLY BLANK

PRECEDING PAGE BLANK NOT FILMED

Item		Page
42	BOLT, EVA HEX-HEAD	B-15
43	CABLE CUTTER	C-1
44	CABLE CUTTER, COMPOUND	C-3
45	CABLE CUTTER, LARGE	C-5
46	CARGO BAY STOWAGE ASSEMBLY	C-7
47	CARRYOUT BRACKET	C-9
48	CENTERLINE LATCH BYPASS TOOL	C-11
49	CENTERLINE LATCH TOOL BAG	C-13
50	CIRCULAR CONNECTOR TOOL	C-15
51	COAX CONNECTOR TOOL	C-17
52	COAX CONNECTOR TOOL, ROUND	C-19
53	CONTINGENCY STRUT WRENCH	C-21
54	COUPLING, HELIUM II RESUPPLY	C-23
55	CUFF CHECKLIST	C-25
56	D-CONNECTOR DEMATE TOOL	D-1
57	D-CONNECTOR MATE TOOL	D-3
58	DIAGONAL CUTTERS	D-5
59	DOOR STAY, ADJUSTABLE, SSM	D-7
60	DOOR STAY, OTA	D-9
61	DOOR SUPPORT BRACKET	D-11
62	DRIVE UNIT PRELOAD TOOL	D-13
63	DROP-PROOF TETHER	D-15
64	ELECTRICAL CIRCULAR CONNECTOR TOOL	E-1
65	ELECTRICAL CONNECTOR AND CAP, EVA	E-3
66	ELECTRICAL CONNECTOR PIN STRAIGHTENER	E-5
67	ELECTRICAL CONNECTOR PIN STRAIGHTENER, MULTISIZE	E-7
68	ELECTRICAL D-CONNECTOR INSTALLATION TOOL	E-9
69	ELECTRICAL D-CONNECTOR REMOVAL TOOL	E-11
70	EMU BATTERY	E-13
71	EMU LIGHTS	E-15
72	EMU LIGHTS BATTERY	E-17
73	EMU TV	E-19
74	EMU TV BATTERY	E-21
75	EMU TV RECEIVER AND VIDEO PROCESSOR ASSEMBLY	E-23
76	EMU WATCH	E-25
77	EQUIPMENT TETHER, ADJUSTABLE	E-27
78	EXTERNAL TANK DOOR LATCH TOOL	E-29
79	EXTRAVEHICULAR MOBILITY UNIT	E-31
80	FASTENER, 1/4-TURN	F-1
81	FLASHLIGHT	F-3
82	FLIGHT SUPPORT SYSTEM LOCKER	F-5
83	FLUID CONNECTOR, EVA	F-7
84	FORCE MEASUREMENT TOOL	F-9
85	FORCEPS	F-11
86	FUSE TRANSFER CONTAINER	F-13
87	HAMMER	H-1
88	HANDRAIL, EVA	H-3
89	HARPOON, EASE TRUSS NODE	H-5
90	HARPOON, SPACE STATION FREEDOM TRUSS NODE	H-7
91	HOOK, FRENCH	H-9

Item		Page
92	HOOK, TRUSS STRUT	H-11
93	HOOK, UNIVERSAL TETHER	H-13
94	HYDRAZINE ANALYZER	H-15
95	HYDRAZINE BALL VALVE HOUSING	H-17
96	HYDRAZINE BRUSH	H-19
97	HYDRAZINE CAP RETAINER ASSEMBLY	H-21
98	HYDRAZINE DETECTOR	H-23
99	HYDRAZINE DUST CAP REMOVER	H-25
100	HYDRAZINE MULTIPURPOSE TOOL	H-27
101	HYDRAZINE NUT RETAINER ASSEMBLY	H-29
102	HYDRAZINE REMOVAL CANISTER	H-31
103	HYDRAZINE RETRIEVAL TOOL	H-33
104	HYDRAZINE RIGHT ANGLE CLIPPER	H-35
105	HYDRAZINE SAFETY WIRE CLIPPER	H-37
106	HYDRAZINE SEAL VERIFICATION TOOL	H-39
107	HYDRAZINE SPANNER WRENCH	H-41
108	HYDRAZINE TOOL SUPPORT BRACE	H-43
109	JETTISON HANDLE	J-1
110	JUMPER CABLE	J-3
111	KNOB, EVA	K-1
112	LATCH, 1/4-TURN DOOR	L-1
113	LEASAT EQUIPMENT STOWAGE ASSEMBLY	L-3
114	LEVER WRENCH	L-5
115	LOOP PIN EXTRACTOR	L-7
116	MAGNETIC HANDLING AID	M-1
117	MAGNETIC PAYLOAD ATTACHMENT DEVICE	M-3
118	MANIPULATOR FOOT RESTRAINT	M-5
119	MANNED MANEUVERING UNIT	M-7
120	MANUAL AFT FRAME TILT ACTUATOR	M-9
121	MECHANICAL FINGER, EVA	M-11
122	MINI WORK STATION	M-13
123	MMU 35-mm CAMERA ACTUATOR	M-15
124	MMU 35-mm CAMERA COVER	M-17
125	MMU 35-mm CAMERA MOUNT	M-19
126	MMU BATTERY	M-21
127	MMU BATTERY RECHARGE CABLE	M-23
128	MMU BATTERY TRANSFER BAG	M-25
129	MMU BATTERY TRANSFER STRAP	M-27
130	MMU FLIGHT SUPPORT STATION	M-29
131	MMU FSS CONTINGENCY TOOL	M-31
132	MMU THRUSTER CUE LIGHT EXTENDER	M-33
133	MODULE SERVICING TOOL	M-35
134	MST MANUAL BACKUP	M-37
135	NEEDLE NOSE PLIERS	N-1
136	NUMBER 10 ALLEN WRENCH EXTENSION FOR 3/8-INCH DRIVE	N-3
137	NUMBER 10 ALLEN WRENCH, L-HANDLE	N-5
138	PAM-D WEDGE	P-1
139	PAYLOAD CLAMP ASSEMBLY DRIVER	P-3
140	PAYLOAD CLAMP ASSEMBLY TORQUE LIMITED DRIVER	P-5
141	PAYLOAD INTERFACE MECHANISM	P-7

Item		Page
142	PAYLOAD INTERFACE MECHANISM ADAPTER	P-9
143	PAYLOAD RETENTION DEVICE	P-11
144	PFR ARTICULATING SOCKET	P-13
145	PFR CENTERLINE CLAMP ASSEMBLY	P-15
146	PFR EXTENDER	P-17
147	PFR SOCKET	P-19
148	PFR SOCKET (HST)	P-21
149	PFR SOCKET, BRIDGE FITTING	P-23
150	PFR SOCKET, SILL LONGERON	P-25
151	PFR WORK STATION STANCHION	P-27
152	PIP PIN	P-29
153	PORTABLE FLOOD LIGHT	P-31
154	PORTABLE FOOT RESTRAINT	P-33
155	PORTABLE FOOT RESTRAINT (HST)	P-35
156	PORTABLE ORU HANDLE, LARGE	P-37
157	PORTABLE ORU HANDLE, SMALL	P-39
158	POWER DRIVE UNIT DISCONNECT	P-41
159	POWER PACKAGE, EVA	P-43
160	POWER RATCHET TOOL	P-45
161	POWER TOOL BATTERY BAG, EVA	P-47
162	POWER TOOL BATTERY, EVA	P-49
163	POWER TOOL BATTERY, MINI	P-51
164	POWER TOOL, EVA	P-53
165	POWER TOOL, EVA (HST)	P-55
166	POWER TOOL, MINI	P-57
167	POWER TOOL, SMART	P-59
168	PROBE	P-61
169	PROVISIONS STOWAGE ASSEMBLY	P-63
170	PRY BAR	P-65
171	RATCHET WITH 15/16-INCH HEX SOCKET	R-1
172	RETAINING MECHANISM, TOOL	R-3
173	RETRACTABLE TETHER	R-5
174	RIGHT ANGLE DRIVE	R-7
175	RMS MPM WRENCH	R-9
176	RMS PFR ATTACHMENT DEVICE	R-11
177	RMS ROPE REEL	R-13
178	RMS SHOULDER BRACE RELEASE TOOL	R-15
179	SAFETY TETHER	S-1
180	SAW	S-3
181	SCISSORS, EMU	S-5
182	SCISSORS, MODIFIED	S-7
183	SCREWS, EVA CAPTIVE	S-9
184	SHORTING PLUG	S-11
185	SHROUDED FLEX SCREWDRIVER	S-13
186	SHROUDED RIGID SCREWDRIVER	S-15
187	SHROUDED SCREWDRIVER EXTENSION FOR 3/8-INCH DRIVE	S-17
188	SHUTTLE UMBILICAL RETRACTION SYSTEM WRENCH	S-19
189	SNATCH BLOCK	S-21
190	SPACECRAFT ADAPTER	S-23
191	SPECIAL EQUIPMENT STOWAGE ASSEMBLY	S-25

Item		Page
192	SPREADER ASSEMBLY	S-27
193	SWITCH, EVA	S-29
194	T-HANDLE	T-1
195	T-HANDLE, ELECTRICAL CONNECTOR CAP	T-3
196	TAPE CADDY, KAPTON	T-5
197	TELESCOPING BOOM	T-7
198	TENSIONING BUCKLE	T-9
199	TETHER HOOK, ONE-HANDED	T-11
200	TETHER HOOK, QUICK ATTACH	T-13
201	TETHER POINT	T-15
202	THERMAL MITTENS	T-17
203	THREE-POINT LATCH TOOL	T-19
204	THREE-POINT LATCH TOOL BAG	T-21
205	TOOL BOARD	T-23
206	TOOL BOARD, CUSHIONED	T-25
207	TOOL BOX (HST)	T-27
208	TOOL CADDY	T-29
209	TOOL CADDY, McCADDY AND RATCHET	T-31
210	TOOL CONTAINER ASSEMBLY	T-33
211	TOOL STOWAGE BAG	T-35
212	TORQ-SET TIP EXTENSION	T-37
213	TORQ-SET TIP EXTENSION (HST)	T-39
214	TORQUE LIMITER, MULTISETTING	T-41
215	TORQUE MULTIPLIER	T-43
216	TORQUE RECORDER WITH 7/16-INCH HEX SOCKET	T-45
217	TORQUE WRENCH	T-47
218	TRANSFER BAG	T-49
219	TRASH BAG, LARGE	T-51
220	TRASH BAG, SMALL	T-53
221	TRUNNION PIN ATTACHMENT DEVICE	T-55
222	TUBE CUTTER	T-57
223	VELCRO CADDY	V-1
224	VISE-GRIP PLIERS	V-3
225	VISE-GRIP PLIERS, ONE-HANDED	V-5
226	WAIST TETHER	W-1
227	WINCH, EVA	W-3
228	WRIST MIRROR	W-5
229	WRIST TETHER	W-7
230	WRIST TETHER, ADJUSTABLE	W-9

Section		Page
APPENDIX A	COMMENT/REQUEST RETURN FORM	AA-1
APPENDIX B	SUPPLEMENTAL TOOL INFORMATION	BB-1
APPENDIX C	EQUIPMENT CLASSIFICATION	CC-1
APPENDIX D	REFERENCES	DD-1
APPENDIX E	ACRONYMS	EE-1

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

1/2-INCH ALLEN WRENCH FOR 3/8-INCH DRIVE

OVERVIEW

The 1/2-inch allen wrench for 3/8-inch drive is a part of the inertial upper stage (IUS) jettison tools. It consists of a 1/2-inch allen drive attached to a deepwell socket with two spring pins. The deepwell socket is a commercially available socket modified for EVA use. A rotating tether ring has been added to the socket for restraint during EVA. Unlike similar items, this tool does not utilize a drop-proof tether interface.

OPERATIONAL COMMENTS

The 1/2-inch allen drive provides an interface between a 3/8-inch drive ratchet and the IUS centering spring bolts. It is designed to remove four bolts at the centering springs should the IUS aft airborne support equipment (ASE) need to be jettisoned. This tool is flown only on IUS flights.

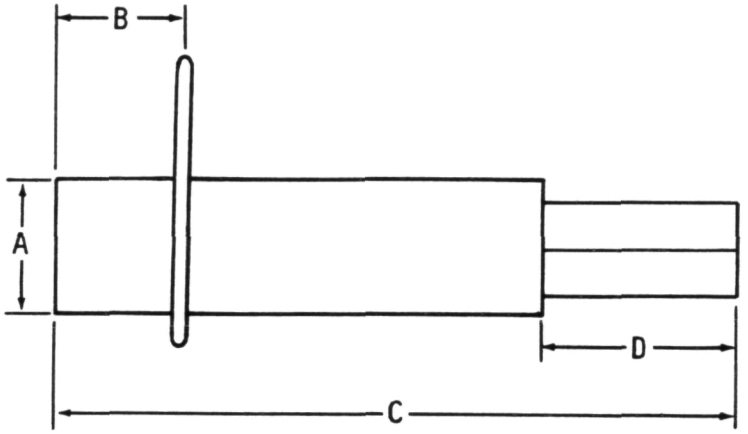
CONTACTS

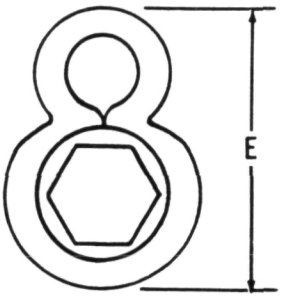
Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

1/2-INCH ALLEN WRENCH FOR 3/8-INCH DRIVE

Technical Information	
Part number	10114-20043-01
Weight	4.3 oz
Material	Tool steel
Quantity flown	Two (IUS flights only)
Stowage	Middeck locker
Availability	Flight specific

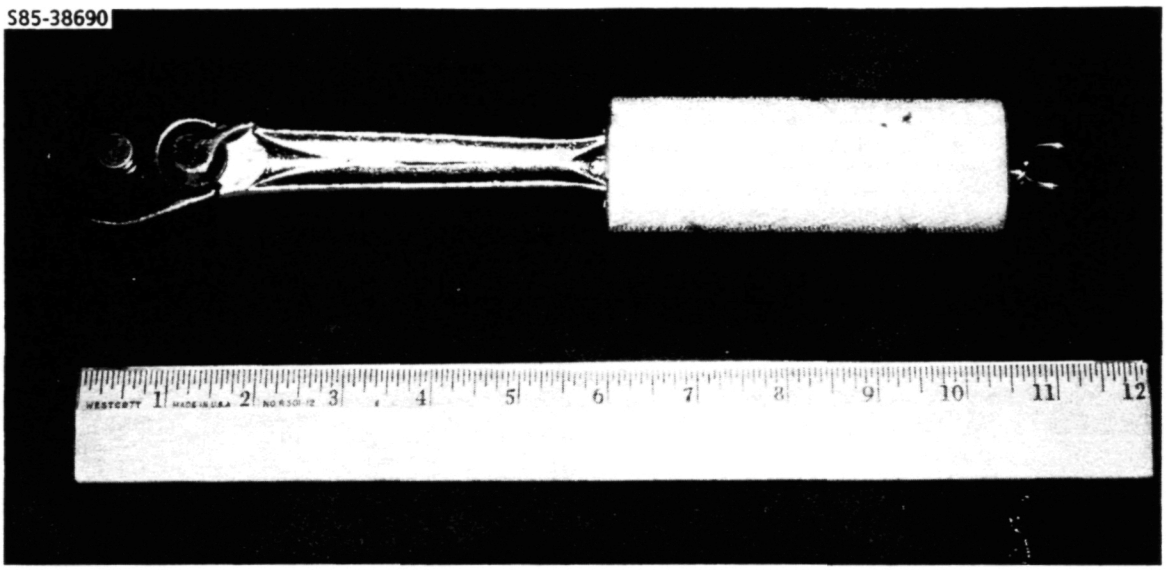
Dimensional Data	
A	0.75 in.
B	0.75 in.
C	3.50 in.
D	1.00 in.
E	1.50 in.





ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

1/2-INCH DRIVE RATCHET



OVERVIEW

The 1/2-inch drive ratchet is a common ratchet modified for EVA use. It allows continuous ratcheting in both clockwise and counterclockwise directions; a small lever is used to select direction. The handle is built up and wrapped with Velcro to provide easy grasping by the gloved hand. A tether ring attached to the end allows wrist tether attachment.

OPERATIONAL COMMENTS

The 1/2-inch drive ratchet is used in disconnecting the Spacelab scientific airlock hatch in the event that the hatch cannot close. It can be used with any 1/2-inch square drive interface.

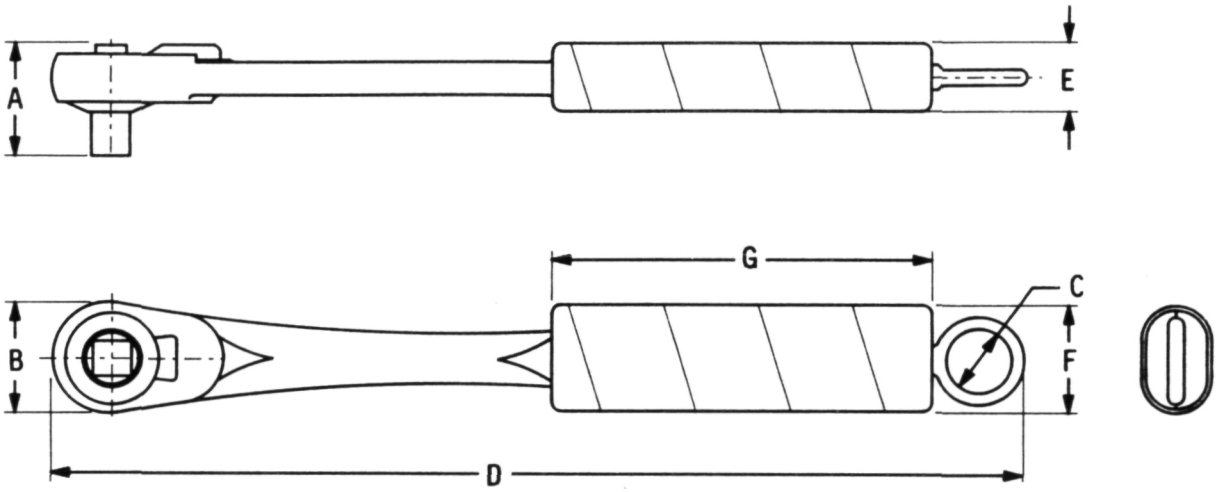
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: J. Madden, Rockwell/Houston, (713) 282-5300

1/2-INCH DRIVE RATCHET

Technical Information	
Part number	V628-650881-004
Weight	0.8 lb
Material/ construction	Tool steel, Velcro-covered handle, and tether ring
Force/torque	Designed for less than 25 ft-lb
Availability	Flight specific

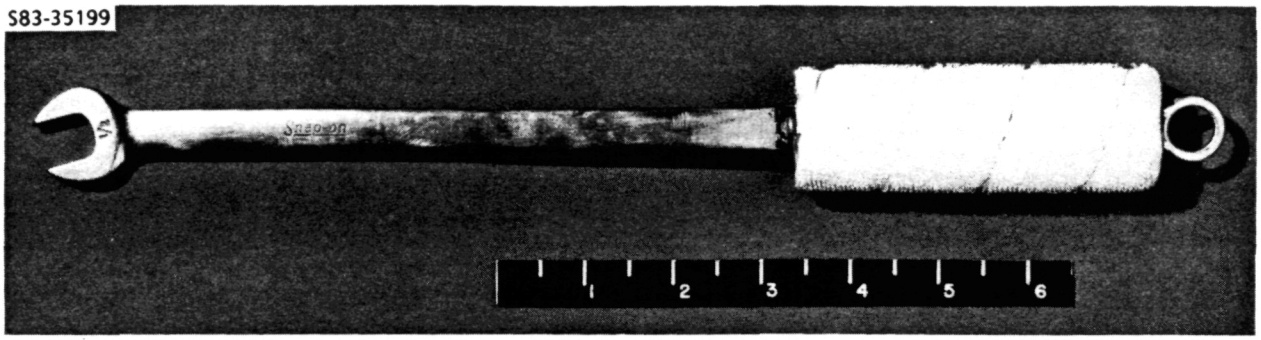
Dimensional Data	
A	1.58 in.
B	1.66 in.
C	0.67 in.
D	11.68 in.
E	0.75 in.
F	1.25 in.
G	4.00 in.



204660001.ART, 3

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

1/2-INCH OPEN END WRENCH



OVERVIEW

The 1/2-inch open end wrench is a common tool modified for EVA use. The handle is built up and wrapped with Velcro to provide easy gripping by the gloved hand. A tether ring is mounted on the end of the handle for tethering.

OPERATIONAL COMMENTS

The 1/2-inch open end wrench is used to disconnect EVA bolts with a 1/2-inch hex or square head. The wrench is not part of the normally manifested Space Transportation System (STS) equipment.

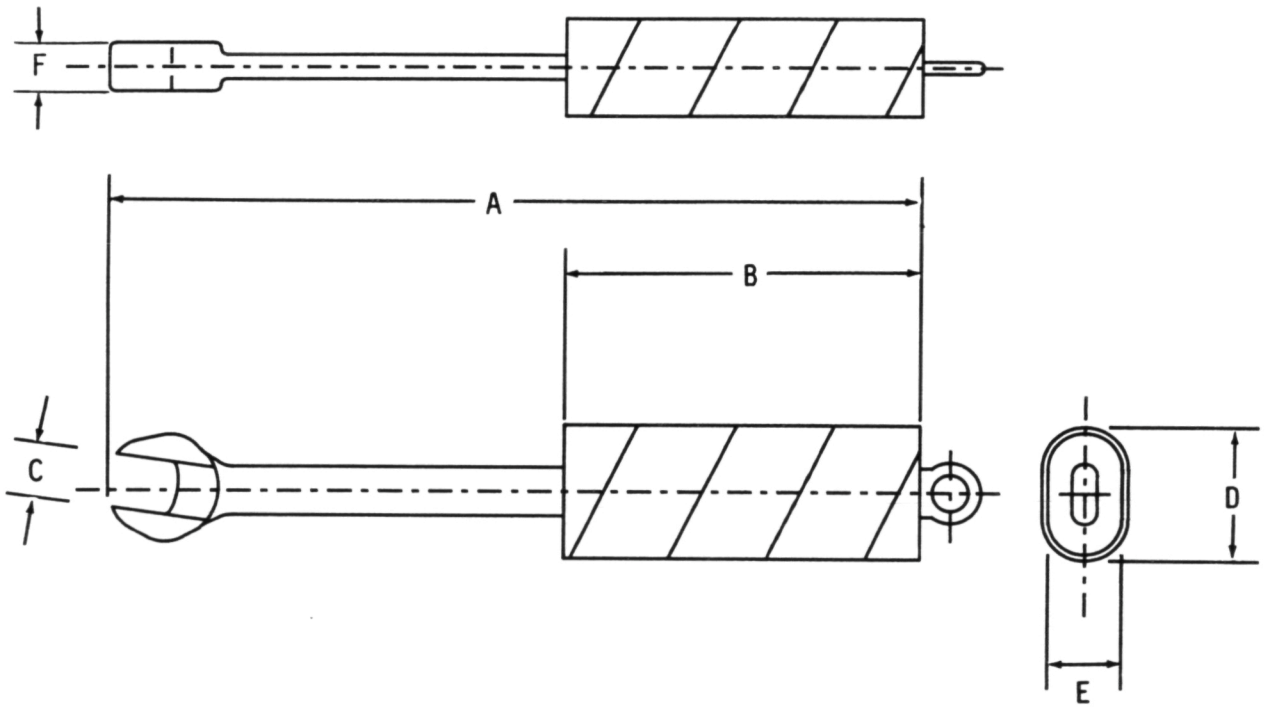
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: J. Madden, Rockwell/Houston, (713) 282-5300

1/2-INCH OPEN END WRENCH

Technical Information	
Part number	V628-650925-005
Weight	0.9 lb
Material/ construction	Wrench - AISI 4063 tool steel Wrench extension - AISI 4130 tool steel Handle - polyurethane, Velcro-wrapped, and tether ring
Wrench vendor	Snap-On Tool Co.
Availability	Reference only

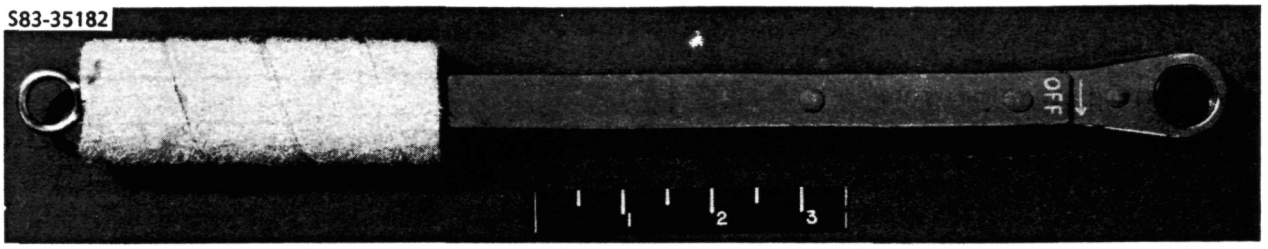
Dimensional Data	
A	9.00 in.
B	4.00 in.
C	0.50 in.
D	1.25 in.
E	0.75 in.
F	0.25 in.



204660002.ART, 4

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

1/2-INCH RATCHETING BOX END WRENCH



OVERVIEW

The 1/2-inch ratcheting box end wrench is a common wrench modified for EVA use. The handle is built up and wrapped with Velcro to provide a positive grip for the gloved hand. A tether ring is mounted on the end of the handle for tethering.

OPERATIONAL COMMENTS

In the event of failure of the RMS to release the payload grapple fixture, the 1/2-inch ratcheting box end wrench is used to disconnect the grapple fixture from the payload. The wrench can also be used to install or disconnect any bolts with 1/2-inch heads. A part of the normally manifested STS equipment, it is wrapped in a Velcro caddy along with the cable cutters and is stowed in the starboard provisions stowage assembly (PSA).

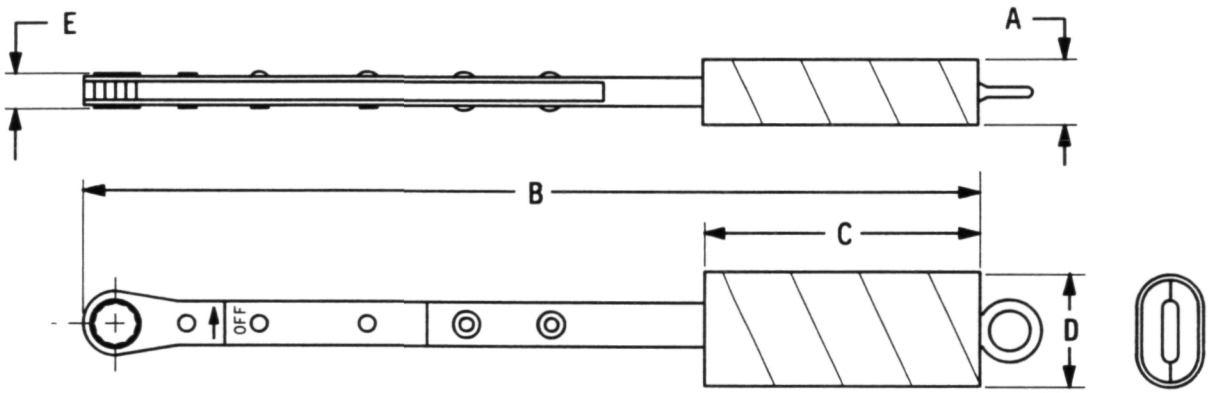
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: J. Madden, Rockwell/Houston, (713) 282-5300

1/2-INCH RATCHETING BOX END WRENCH

Technical Information	
Part number	V628-650885-004 or SDD33103441-301
Weight	1.0 lb
Material/ construction	Handle - polyurethane, flat black, Velcro-wrapped Lubricant - Molykote 321R
Box end	1/2-in., 12-point
Temperature range	-200° to 250° F (operational)
Quantity flown	One in the starboard PSA
Wrench vendor	Snap-On Tool Co.
Availability	Standard

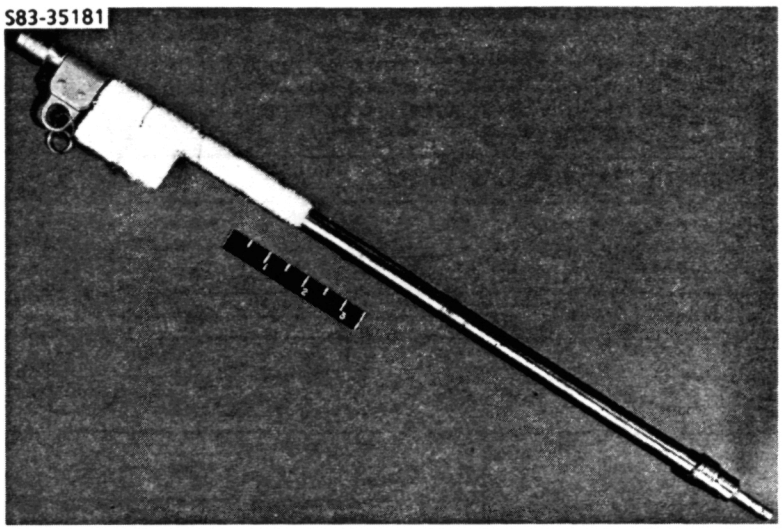
Dimensional Data	
A	0.750 in.
B	12.500 in.
C	4.000 in.
D	1.250 in.
E	0.375 in.



204660003.ART, 3

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

1/4-INCH ALLEN WRENCH EXTENSION FOR 3/8-INCH DRIVE



OVERVIEW

The 1/4-inch allen wrench extension for 3/8-inch drive is a combination of common tools modified for EVA use, a 3/8-inch drive extension with a 1/4-inch allen wrench socket pinned onto the end. The extension has been narrowed near the drive end to allow attachment of a collar with a tool ring for tether attachment. The tool is partially wrapped with Velcro and has Velcro tabs for easy gripping and storage.

OPERATIONAL COMMENTS

In the event of a radiator deployment mechanism failure, this extension is used with the 3/8-inch drive ratchet to disconnect the mechanism manually. The tool is part of the normally manifested STS equipment. It is wrapped in a Velcro-lined caddy along with a 3/8-inch drive ratchet and stowed in the starboard provisions stowage assembly (PSA). The extension does not use the drop-proof tether system.

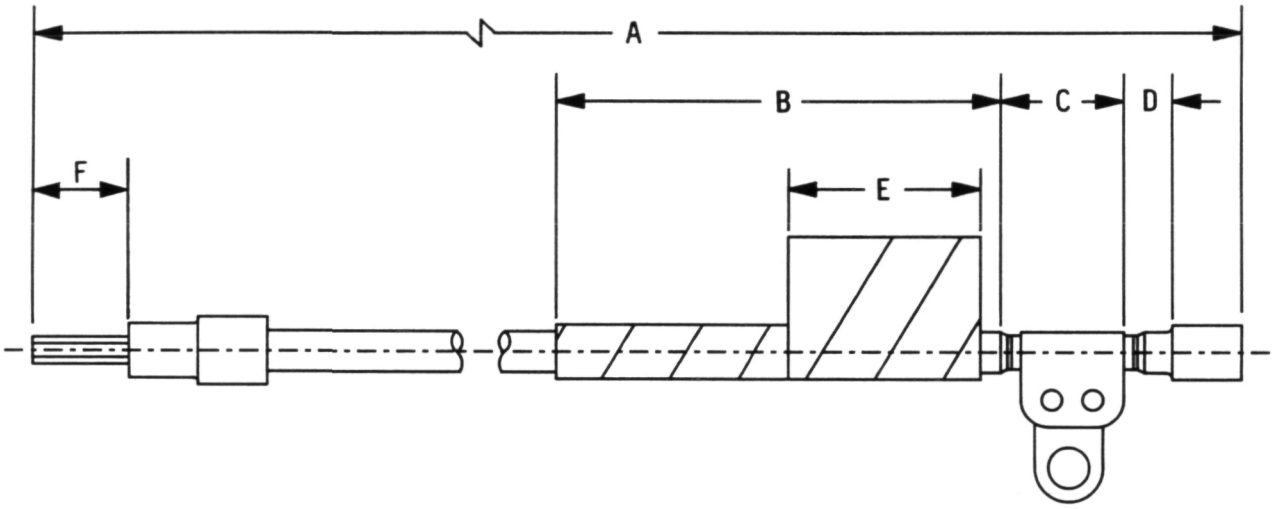
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: J. Madden, Rockwell/Houston, (713) 282-5300

1/4-INCH ALLEN WRENCH EXTENSION FOR 3/8-INCH DRIVE

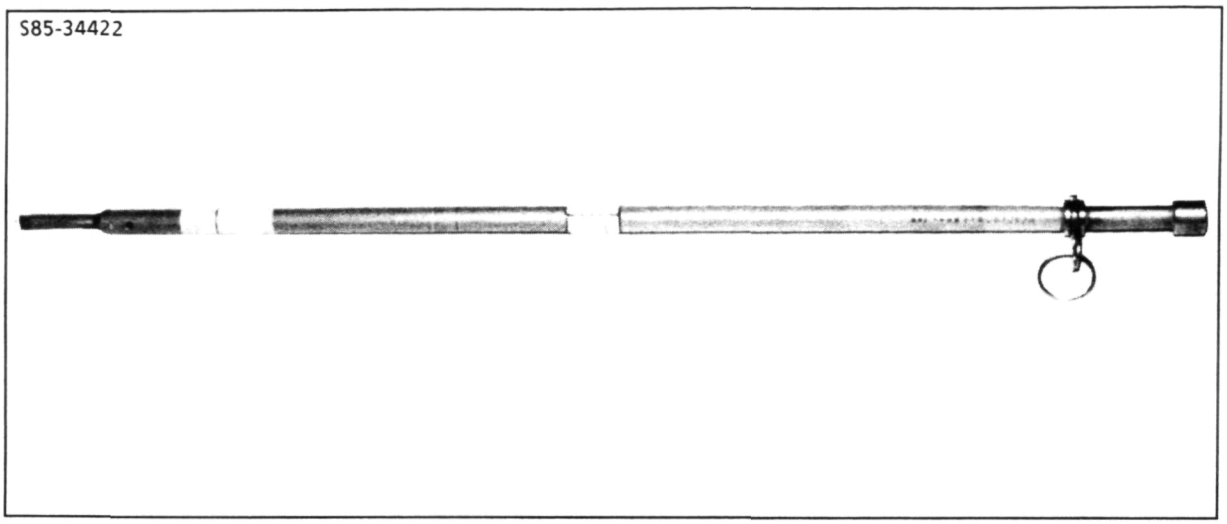
Technical Information	
Part number	V628-650896-004 or SDD33103446-301
Weight	1.0 lb
Material/ construction	Extension - AISI 8640 nickle-plated steel Hex socket - AISI 8640 nickle-plated steel Rivet - NAS 1200-6
Temperature range	-200° to 250° F (operational)
Quantity flown	One in the starboard PSA
Availability	Standard

Dimensional Data	
A	19.70 in.
B	5.25 in.
C	1.06 in.
D	0.38 in.
E	2.00 in.
F	1.00 in.



204660004.ART, 4

1/4-INCH ALLEN WRENCH EXTENSION FOR 3/8-INCH DRIVE (IPS)



OVERVIEW

This 25-inch extension for a 3/8-inch drive has a 1/4-inch allen hex at the end. It has a rotating tether ring near the top for tethering during use.

OPERATIONAL COMMENTS

The 1/4-inch allen wrench extension provides an interface between the EVA 3/8-inch drive ratchet and the Spacelab instrument pointing system (IPS) jettison bolts. It is designed to remove four jettison bolts, but could be used on any 1/4-inch allen bolt if a long extension were required.

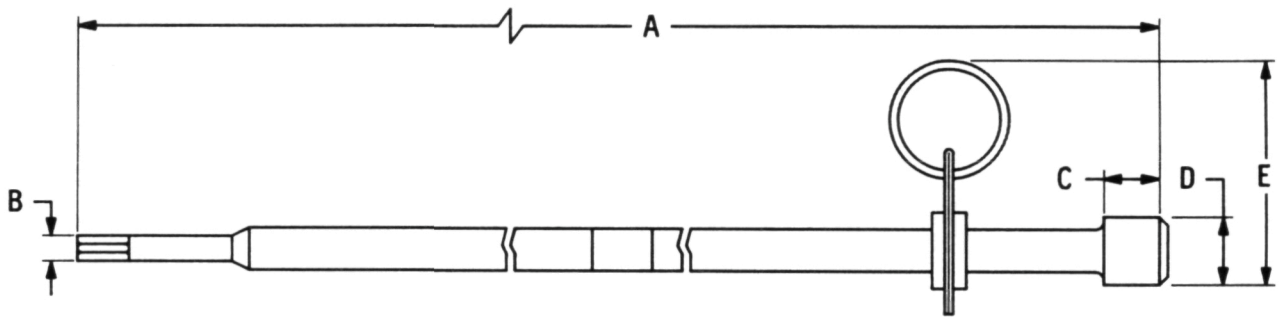
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: M. Naderi, NASA/MSFC, (205) 554-2196
Source: Dornier Space Systems, Germany

1/4-INCH ALLEN WRENCH EXTENSION FOR 3/8-INCH DRIVE (IPS)

Technical Information	
Part number	883-400310.00.0
Weight	1.9 lb
Material/ construction	Tool steel, rotating tether ring
Temperature range	-150° to 250° F
Quantity flown	One for Spacelab IPS mission
Availability	Flight specific

Dimensional Data	
A	24.55 in.
B	0.36 in.
C	0.65 in.
D	0.80 in.
E	2.65 in.

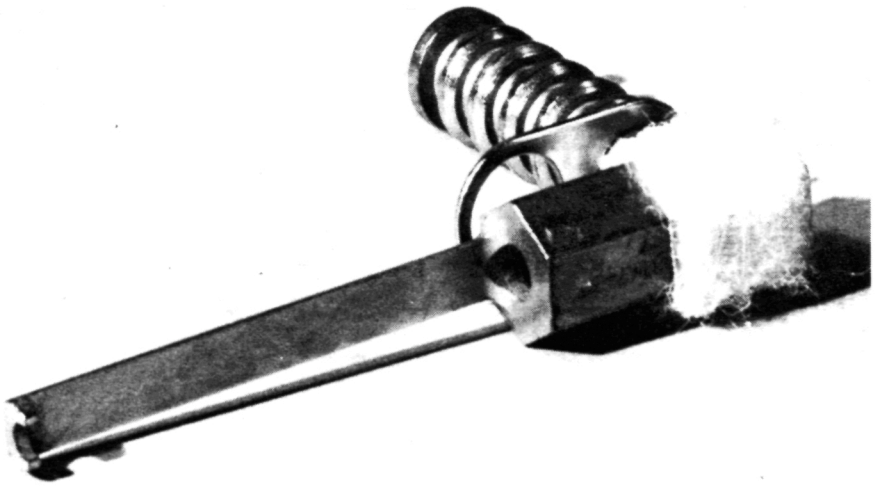


204660005.ART;2

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

1/4-INCH CROW'S FOOT WRENCH

S85-40830



OVERVIEW

The 1/4-inch crow's foot wrench is a 1/4-inch open-ended hexagonal wrench designed specifically for use during the Solar Maximum Satellite (Solar Max) Repair Mission. A ring is attached to the handle for tethering during EVA. Hook Velcro is attached to the upper barrel of the crow's foot to facilitate stowage in a tool caddy.

OPERATIONAL COMMENTS

During the Solar Max Mission, the wrench was used to aid in disassembly of a subminiature D-connector by preventing the movement of a hexagonal standoff post. This tool was developed specifically for use with the shrouded screwdriver extension for Solar Max, but may be used for similar assemblies. The shrouded screwdriver is inserted into the hollow support for the crow's foot, and can be used to tighten or loosen a screw captured by a 1/4-inch nut.

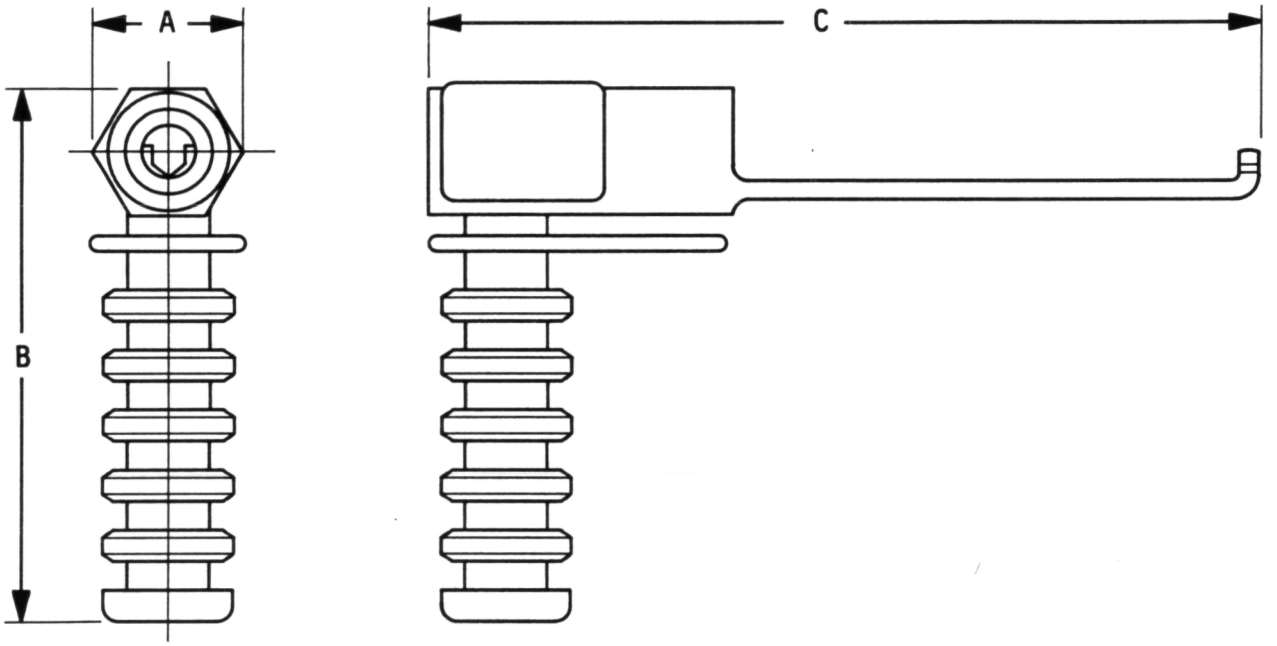
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: T. Ross, NASA/ES6, (713) 483-8941
Source: T. Ross, NASA/ES6, (713) 483-8941

1/4-INCH CROW'S FOOT WRENCH

Technical Information	
Part number	SED-33103147-301
Weight	0.40 lb
Material	Handle - stainless steel Wrench - Ketos Velcro - hook
Operational temperature range	-150° to +280° F
Availability	Flight specific

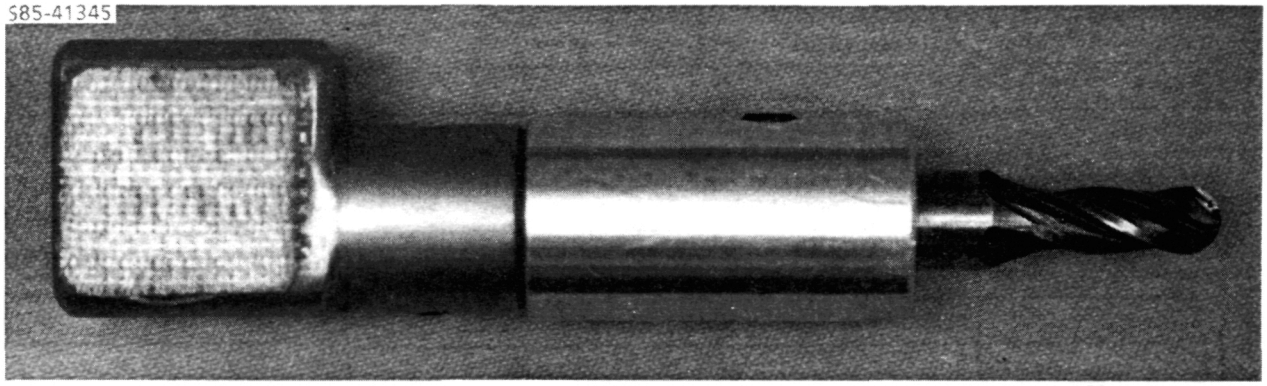
Dimensional Data	
A	0.87 in.
B	3.25 in.
C	5.00 in.



204660006. ART, 4

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

1/4-INCH DRILL EXTENSION FOR 3/8-INCH DRIVE



OVERVIEW

The 1/4-inch drill extension for the 3/8-inch drive is a contingency tool that can be used to remove the head of a socket head cap screw if traditional removal methods fail. It consists of a 1/4-inch right-hand cobalt-tip ball end mill with an aluminum sleeve and a stainless steel drop-proof tether. One side of the drop-proof tether is Velcro-covered to allow attachment to a tool caddy.

OPERATIONAL COMMENTS

The 1/4-inch drill extension was designed for use during the Solar Maximum Satellite (Solar Max) Repair Mission. A quick-release pin is used to connect or disconnect the drop-proof tether from a 3/8-inch driver such as the EVA power tool. A large amount of force and time are required when drilling with this tool, and it is not recommended for nominal EVA procedures. The drill extension was stowed in the flight support system (FSS) locker inside a tool caddy for the Solar Max mission but was not used.

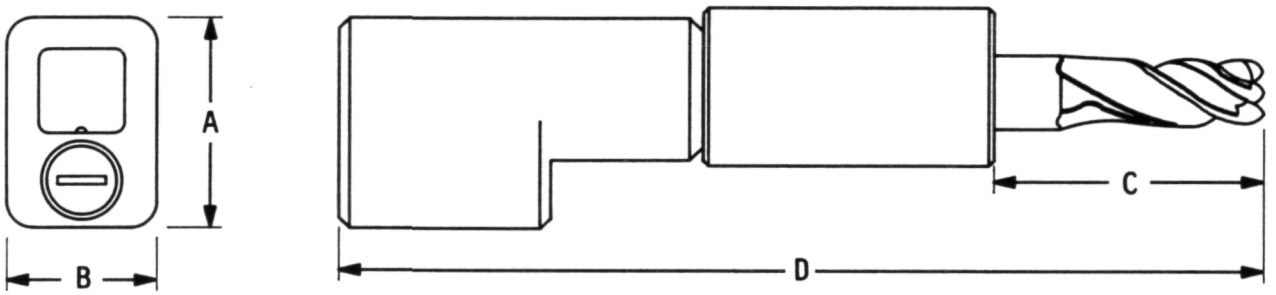
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

1/4-INCH DRILL EXTENSION FOR 3/8-INCH DRIVE

Technical Information	
Part number	10172-20551-01
Weight	0.3 lb
Material	Drill bit - cobalt Drill bit sleeve - aluminum Drop-proof tether - stainless steel Velcro - astro hook
Operational temperature range	-150° to +280° F
Stowage	FSS locker tool caddy #5 for STS 41-C
Availability	Flight specific

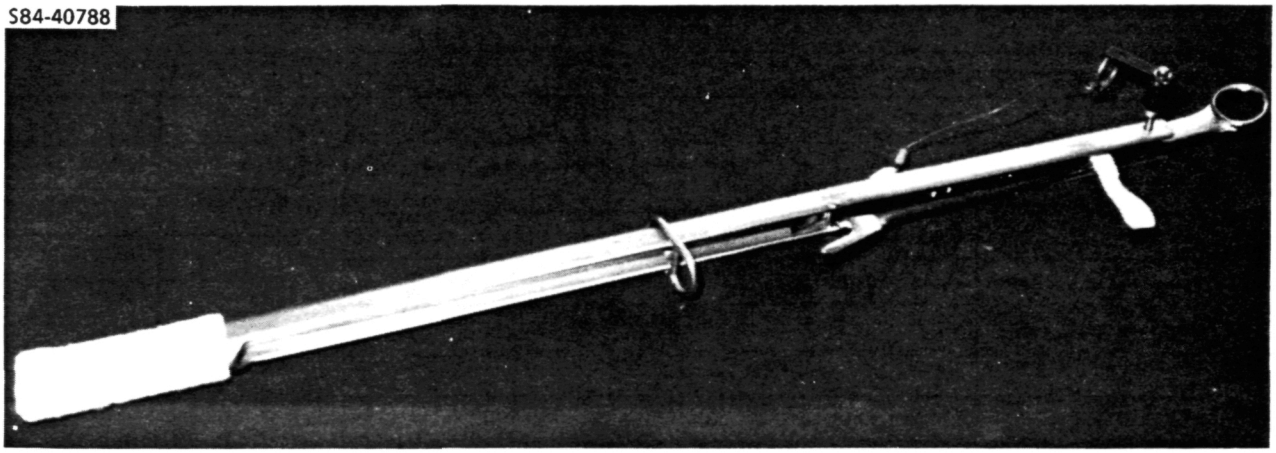
Dimensional Data	
A	1.00 in.
B	0.70 in.
C	1.25 in.
D	4.35 in.



204660007.ART, 3

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

15/16-INCH WRENCH WITH CHEATER BAR



OVERVIEW

The 15/16-inch wrench with cheater bar is a combination open end/box end wrench with an extension. The wrench is held in place by a T-handled pip pin. The bar has a sliding tether point and a Velcro-wrapped handle. The bar is made of stainless steel, and the wrench is tool steel.

OPERATIONAL COMMENTS

The 15/16-inch wrench with cheater bar has a moment arm of 28.5 inches for extra leverage on tight bolts. The cheater bar was used to break loose remote engagement mechanism (REM) bolts on the Spartan satellite. A different size wrench could easily be modified to fit into the cheater bar. This tool is not normally manifested.

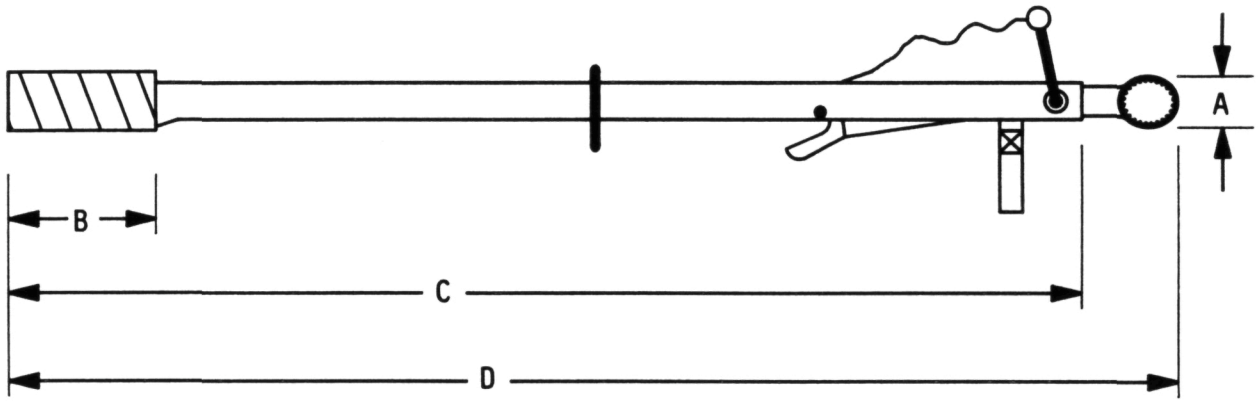
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: R. Scott, NASA/GSFC, (301) 286-2210
Source: R. Scott, NASA/GSFC, (301) 286-2210

15/16-INCH WRENCH WITH CHEATER BAR

Technical Information	
Part number	30A60725
Weight	2.9 lb
Material/ construction	Stainless steel bar, tool steel wrench, Velcro-wrapped handle
Torque	1000 in-lb max with extension
Temperature range	-130° to 150° F
Availability	Flight specific

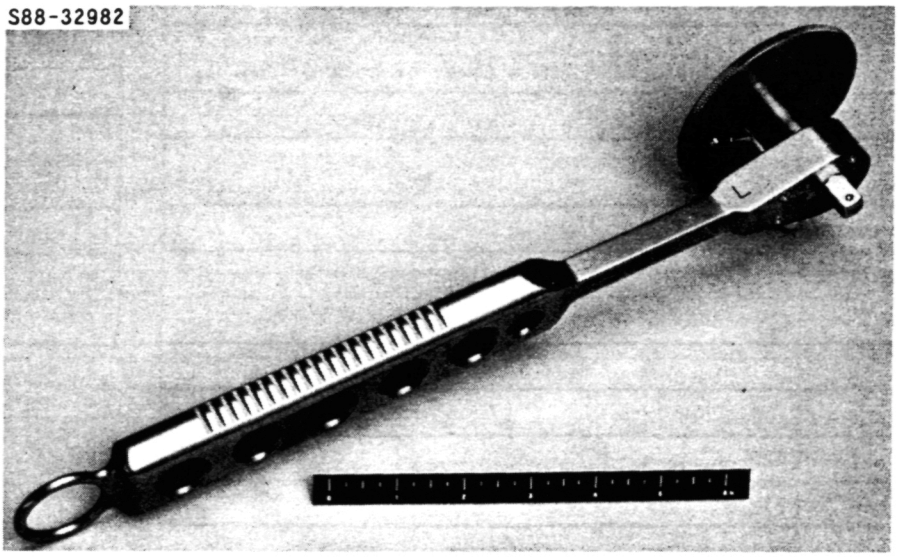
Dimensional Data	
A	1.3 in.
B	4.0 in.
C	25.0 in.
D	28.5 in.



204660008.ART;3

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

3/8-INCH DRIVE McTETHER RATCHET



OVERVIEW

The 3/8-inch drive McTether ratchet is an Essex-style wrench with a built-in drop-proof tether interface. The tool has a palm wheel, a grooved handle, and a tether ring. It has been designed specifically for Hubble Space Telescope (HST) maintenance.

OPERATIONAL COMMENTS

The 3/8-inch drive McTether ratchet is intended for use with sockets or extensions equipped with a drop-proof tether. The -02 ratchet incorporates a double pawl to decrease the backdrive and improve the performance of the tool. EVA restraint for this tool can be provided by the ratchet tool caddy described later in this catalog.

CONTACTS

Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

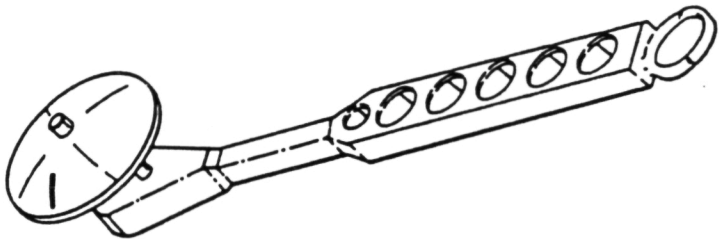
Section 2 PAGE INTENTIONALLY BLANK

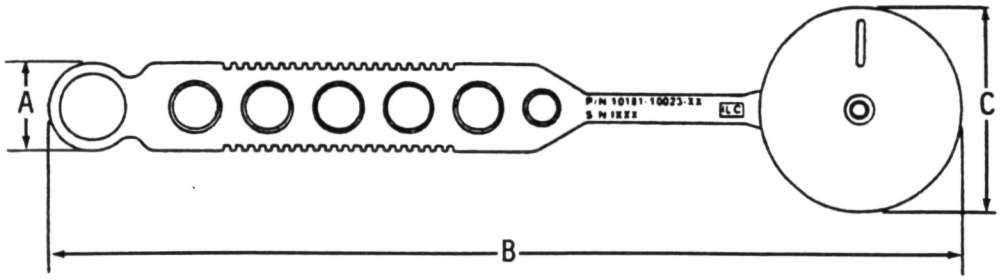
PRECEDING PAGE BLANK NOT FILMED

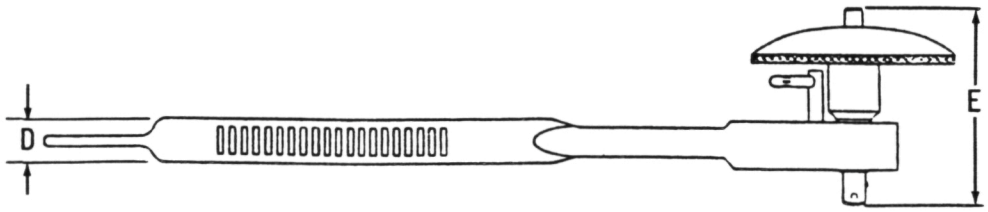
3/8-INCH DRIVE McTETHER RATCHET

Technical Information	
Part number	10181-10023-01 10181-10023-02 (double pawl-low back drive)
Weight	1.34 lb
Material/ construction	Anodized aluminum
Temperature range	-150° to +250° F
Force/torque	50 ft-lb
Backdrive	Less than 6 in-oz
Availability	Flight specific

Dimensional Data	
A	1.50 in.
B	15.62 in.
C	3.50 in..
D	0.75 in.
E	3.34 in.

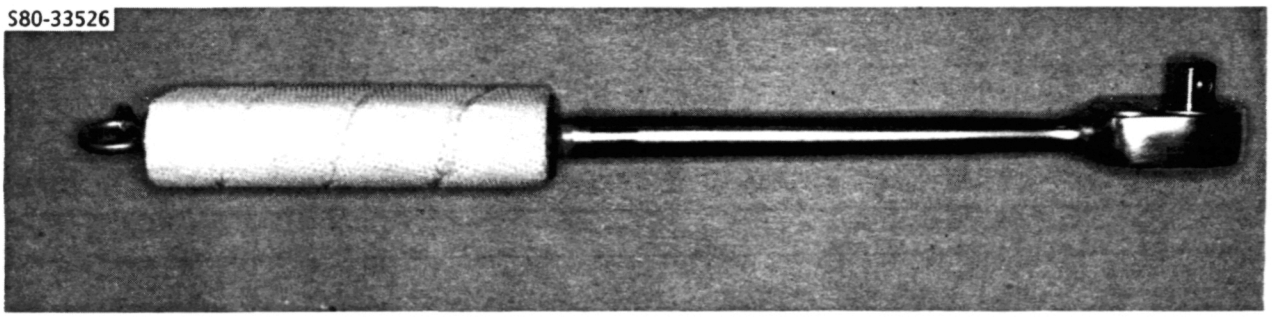






ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

3/8-INCH DRIVE RATCHET



OVERVIEW

The 3/8-inch drive ratchet is a common tool modified for EVA use. It allows ratcheting in both directions; a small lever is used to select direction. A tether ring is mounted on the end of the handle for tethering.

OPERATIONAL COMMENTS

The 3/8-inch drive ratchet is used as a contingency radiator disconnect tool in conjunction with a 3/8-inch drive extension and a 1/4-inch hex. This ratchet is part of the normally manifested STS equipment. It is wrapped in a Velcro-lined tool caddy along with the 1/4-inch allen wrench extension and is stowed in the starboard provisions stowage assembly (PSA).

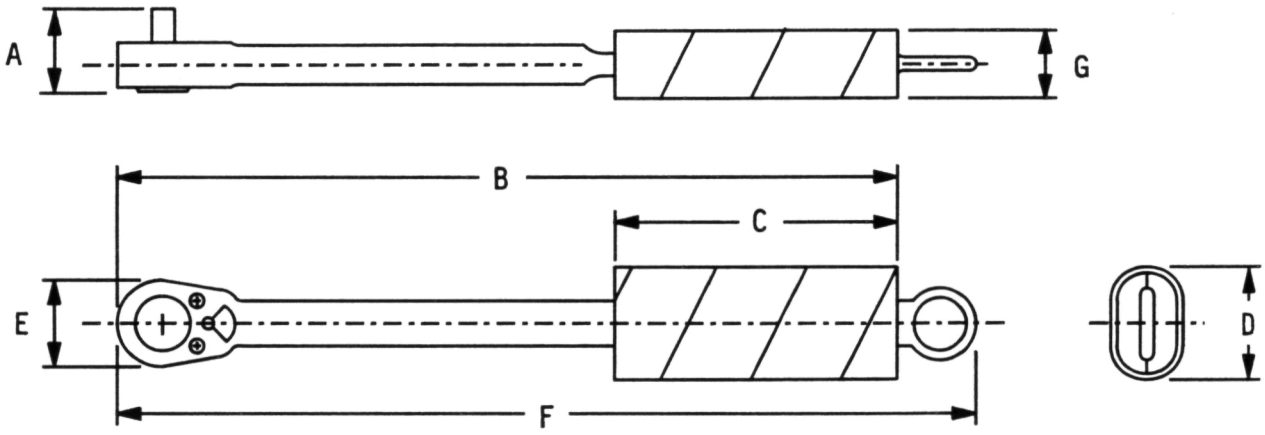
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: J. Madden, Rockwell/Houston, (713) 282-5300

3/8-INCH DRIVE RATCHET

Technical Information	
Part number	V628-650881-004 or SDD33103447-301
Weight	0.84 lb
Material/ construction	Tool steel, Velcro-wrapped handle with tether ring Lubricant - Molykote 321R
Temperature range	-200° to 250° F (operational)
Quantity flown	One
Stowage	Starboard PSA
Availability	Standard

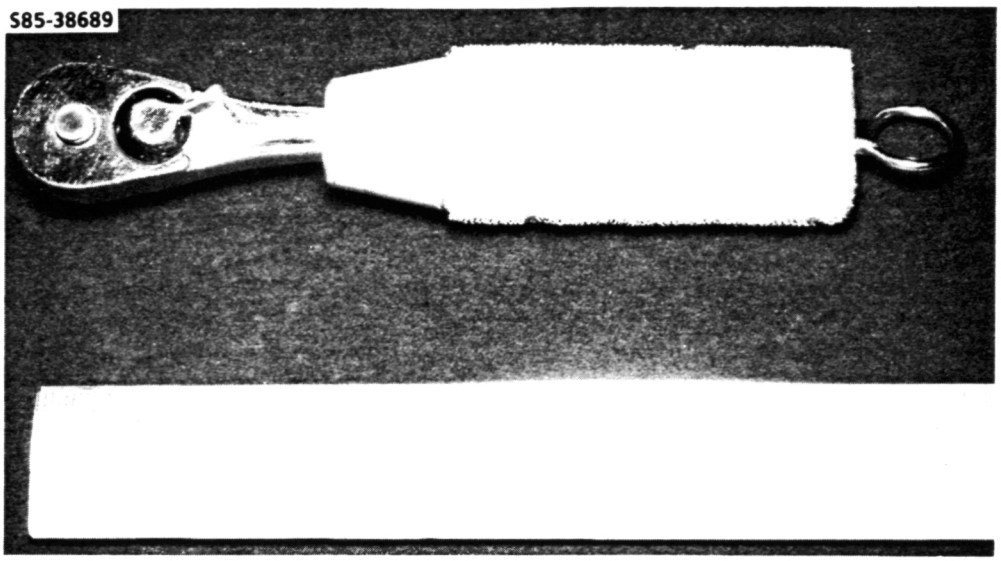
Dimensional Data	
A	1.000 in.
B	11.000 in.
C	4.000 in.
D	1.500 in.
E	1.125 in.
F	11.500 in.
G	0.750 in.



204660009.ART, 4

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

3/8-INCH DRIVE RATCHET (SAL)



OVERVIEW

The 3/8-inch drive ratchet is a bidirectional ratcheting tool with continuous ratcheting in both directions. A lever is provided for selection of ratchet direction. A tether ring is provided for tethering.

OPERATIONAL COMMENTS

The 3/8-inch drive ratchet is flown as a contingency experiment table jettison tool for the Spacelab scientific airlock (SAL). It has a Velcro-wrapped handle and an attached tether ring. It is wrapped in a Velcro-lined tool caddy along with the 1/2-inch drive ratchet and the carryout bracket.

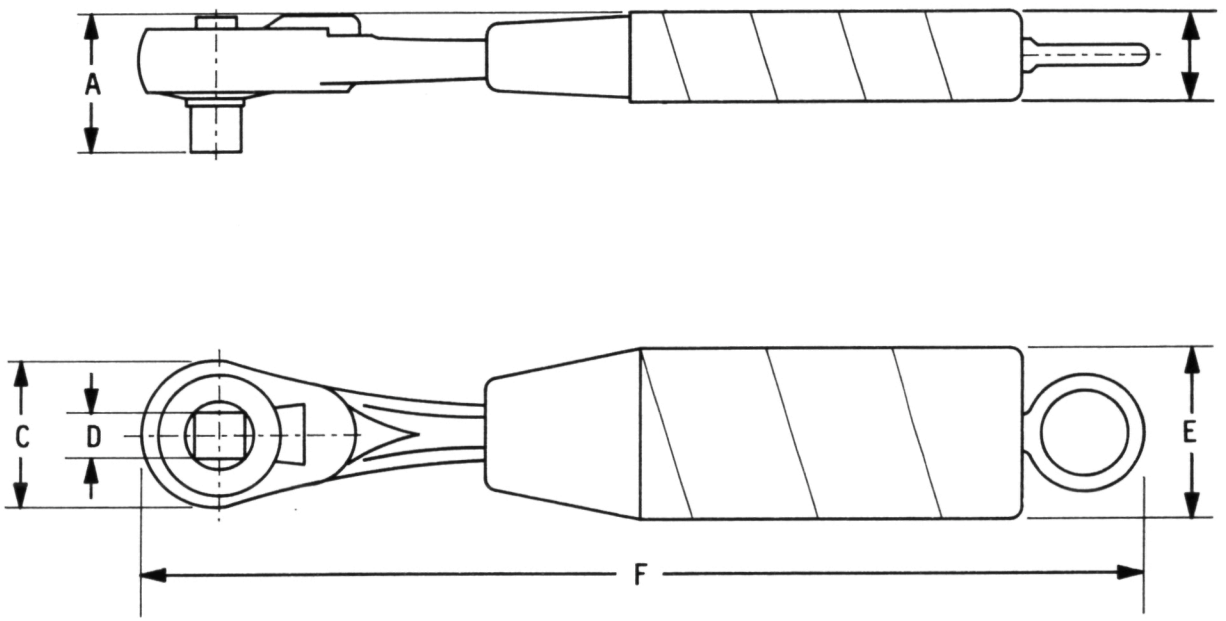
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space systems, (713) 488-9080

3/8-INCH DRIVE RATCHET (SAL)

Technical Information	
Part number	10159-20079-01
Weight	0.84 lb
Material	Tool steel, Velcro-covered handle, tether ring
Temperature	-250° to 200° F
Operational direction	Clockwise and counterclockwise
Quantity flown	One
Stowage	Tool caddy in SAL
Availability	Flight specific

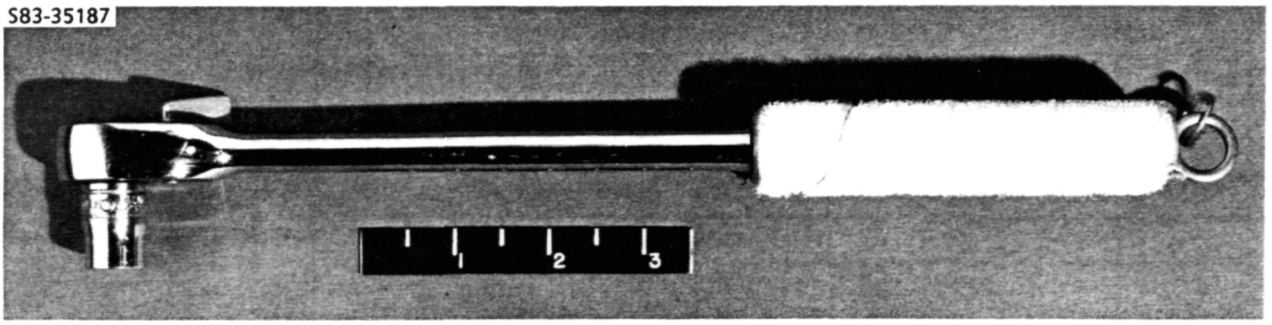
Dimensional Data	
A	1.190 in.
B	0.800 in.
C	1.200 in.
D	0.375 in.
E	1.400 in.
F	8.300 in.



204660013.ART, 1

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

3/8-INCH DRIVE RATCHET WITH 7/16-INCH HEX SOCKET



OVERVIEW

The 3/8-inch drive ratchet with 7/16-inch hex socket is flown as a contingency disconnect tool. The 3/8-inch drive ratchet is a standard commercially available tool modified for EVA support. It allows ratcheting in both the clockwise and counterclockwise directions. The 7/16-inch socket is permanently pinned to the ratchet and allows for the removal of 7/16-inch hex nuts or bolts.

OPERATIONAL COMMENTS

The 3/8-inch drive ratchet with 7/16-inch hex socket is dedicated for use in dismantling the airlock inner hatch if the EVA crew cannot open the hatch to enter the middeck. The 11-inch length of the ratchet allows an adequate lever arm for torquing. This tool is part of the normally manifested STS equipment and is used with the adjustable wrench. It is stowed in the EVA bag during EVA operations.

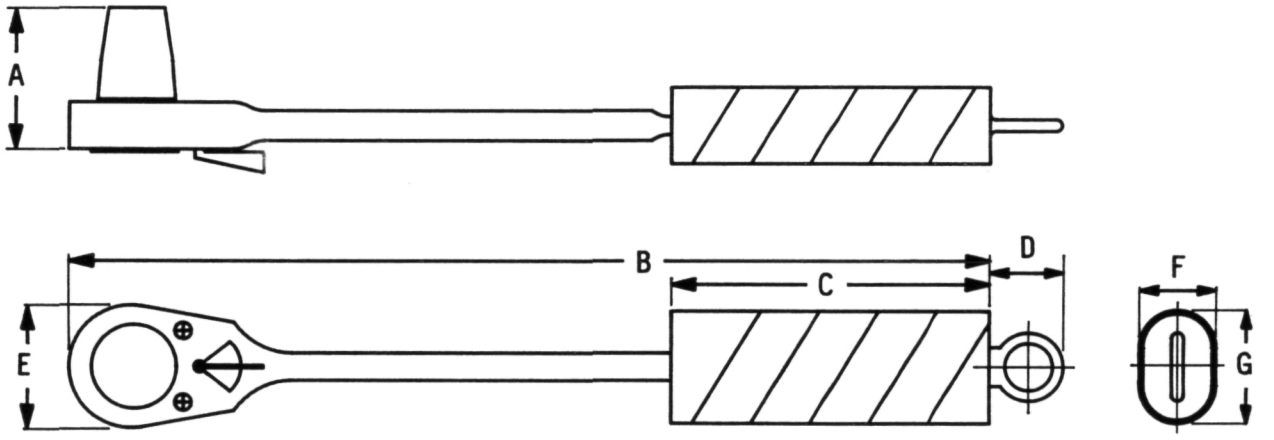
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: J. Madden, Rockwell/Houston, (713) 282-5300

3/8-INCH DRIVE RATCHET WITH 7/16-INCH HEX SOCKET

Technical Information	
Part number	V628-650860-003 or SDD33103432-301
Weight	1.0 lb
Material/ construction	Tool steel, Velcro-wrapped handle Lubricant - Molykote 321R
Socket depth	0.5 in.
Temperature range	-200 to 250° F (operational)
Quantity flown	One
Stowage	EVA bag
Availability	Standard

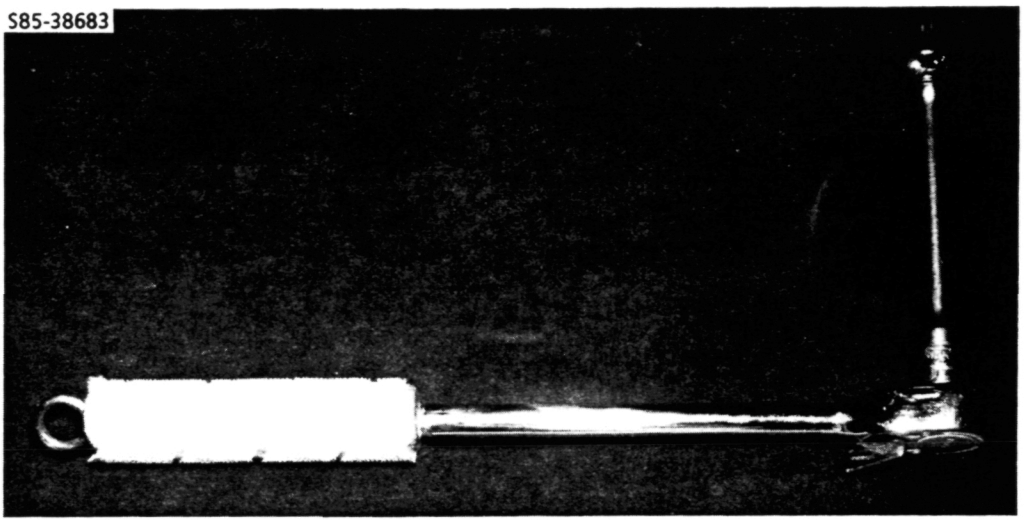
Dimensional Data	
A	1.750 in.
B	11.000 in.
C	4.000 in.
D	1.000 in.
E	1.125 in.
F	0.750 in.
G	1.400 in.



20466001C. ART, 3

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

3/8-INCH DRIVE RATCHET WITH 7/16-INCH HEX SOCKET EXTENSION



OVERVIEW

The 3/8-inch drive ratchet with 7/16-inch hex socket extension is flown as a contingency disconnect tool. The 3/8-inch drive ratchet is a standard commercially available tool modified for EVA use. It allows ratcheting in both the clockwise and counterclockwise directions. The 7/16-inch socket extension is permanently attached to the 3/8-inch ratchet. The extension allows a 4-inch reach to place or remove 7/16-inch hex nuts and bolts. A tether ring is attached to the base of the handle.

OPERATIONAL COMMENTS

The 3/8-inch drive ratchet with 7/16-inch socket extension is dedicated for use in dismantling the airlock outer hatch if the EVA crew cannot open the hatch to enter the airlock. The 11-inch tool length allows an adequate lever arm for torquing. This tool is part of the normally manifested STS equipment. It is wrapped in a Velcro-lined tool caddy along with the adjustable wrench and is stowed in the starboard provisions stowage assembly (PSA).

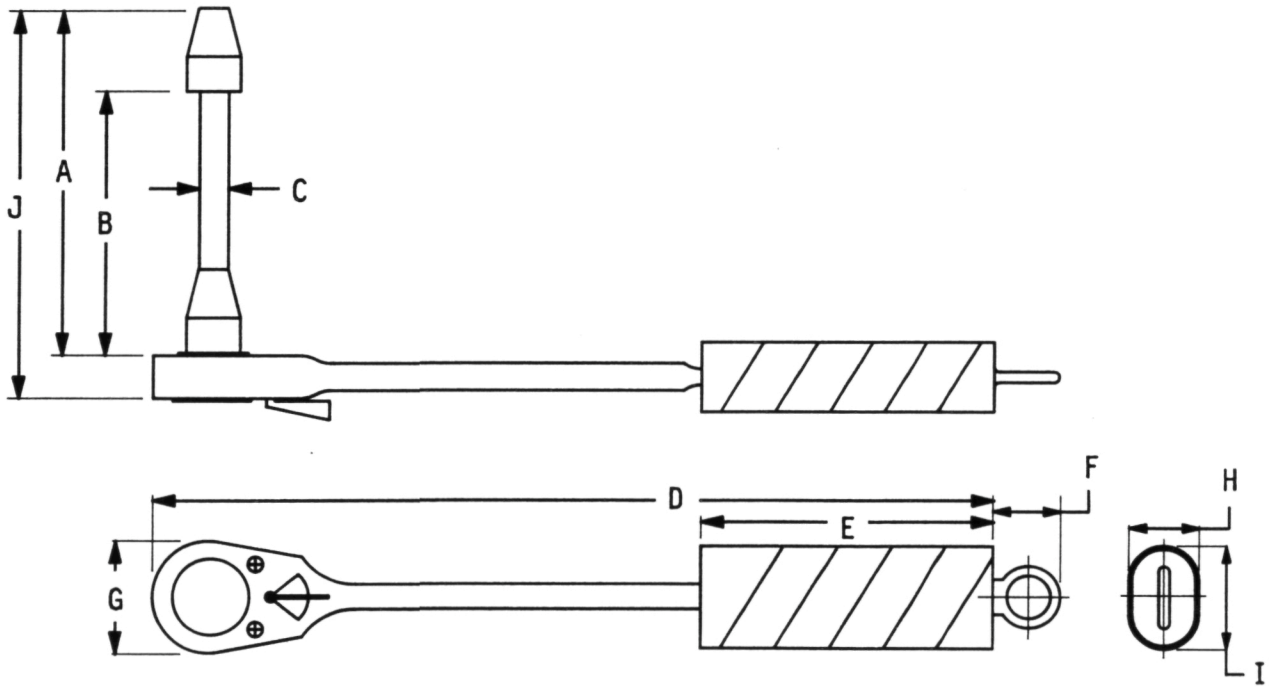
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: J. Madden, Rockwell/Houston, (713) 282-5300

3/8-INCH DRIVE RATCHET WITH 7/16-INCH HEX SOCKET EXTENSION

Technical Information	
Part number	V628-650860 or SDD33103432-303
Weight	1.2 lb
Material/ construction	Forged steel, Velcro-wrapped handle Lubricant - Molykote 321R
Socket depth	0.5 in.
Quantity flown	One
Stowage	Tool caddy in starboard PSA
Availability	Standard

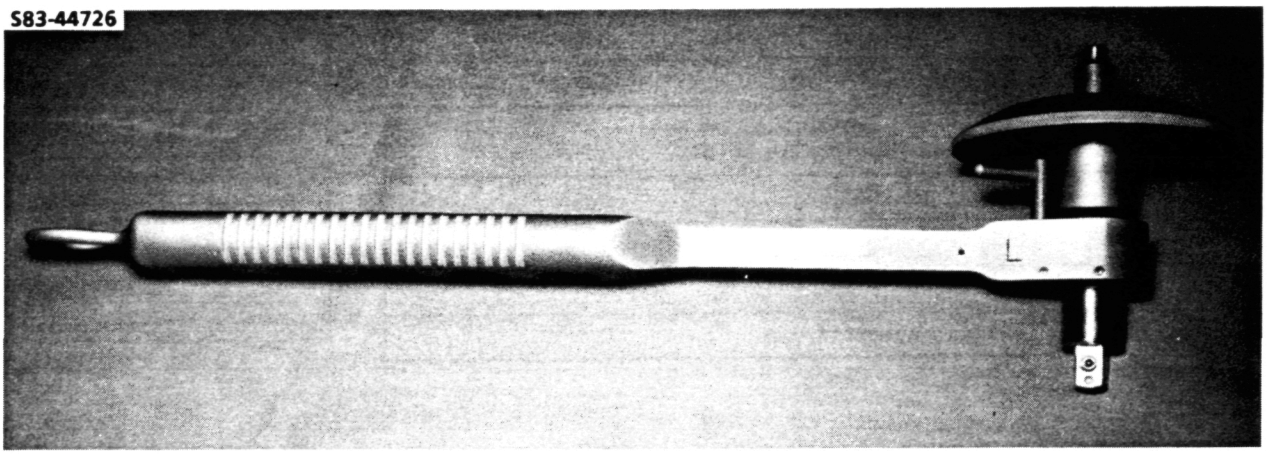
Dimensional Data	
A	4.900 in.
B	4.000 in.
C	0.400 in.
D	11.000 in.
E	4.000 in.
F	1.000 in.
G	1.125 in.
H	0.750 in.
I	1.400 in.
J	5.500 in.



204660011.ART, 2

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

3/8-INCH DRIVE RATCHET, EVA



OVERVIEW

The EVA 3/8-inch drive ratchet, also known as an Essex wrench, is specially designed for EVA use. It allows 360° ratcheting in either direction with a lever for selection of direction. The tool is equipped with a palm wheel which is turned by hand when overtorquing needs to be avoided, or when resistance (backdriving) is insufficient to operate the ratchet. The handle is grooved for better grip and has a tether ring at the end.

OPERATIONAL COMMENTS

The 3/8-inch drive ratchet has a drop-proof tether interface and is intended for use with sockets or extensions equipped with a drop-proof tether. This tool is not normally manifested, but has flown as a backup for the EVA power tool.

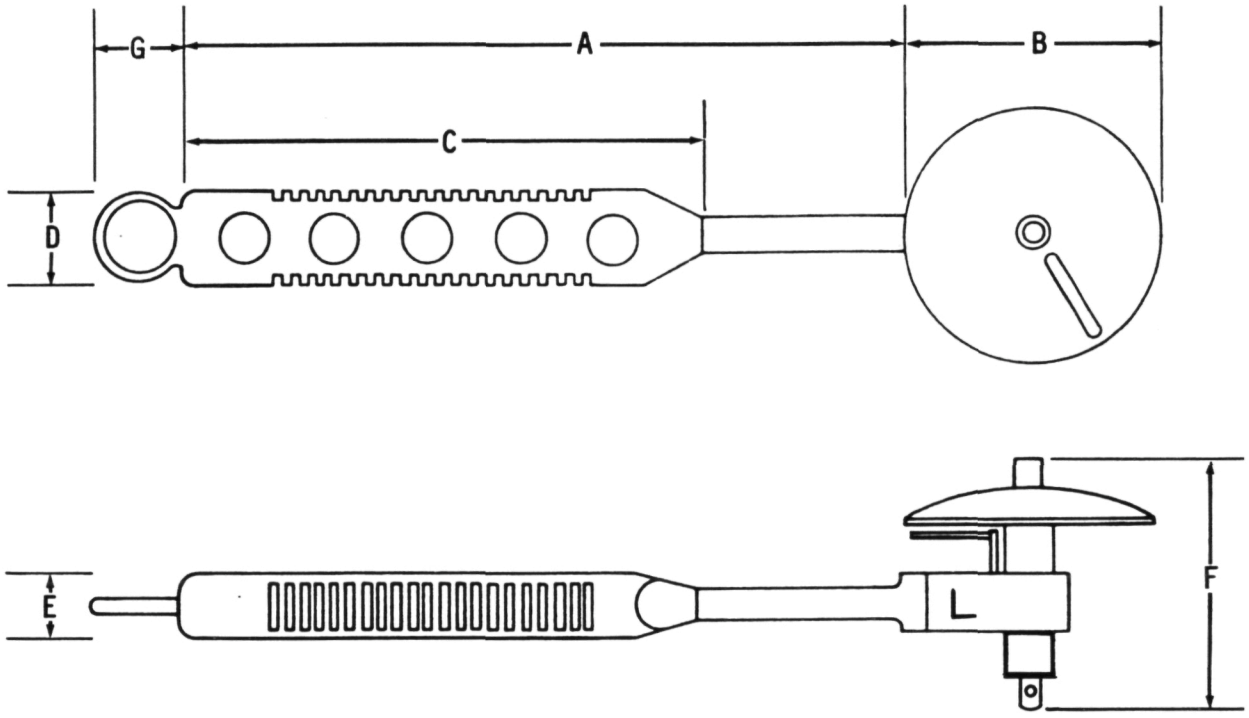
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

3/8-INCH DRIVE RATCHET, EVA

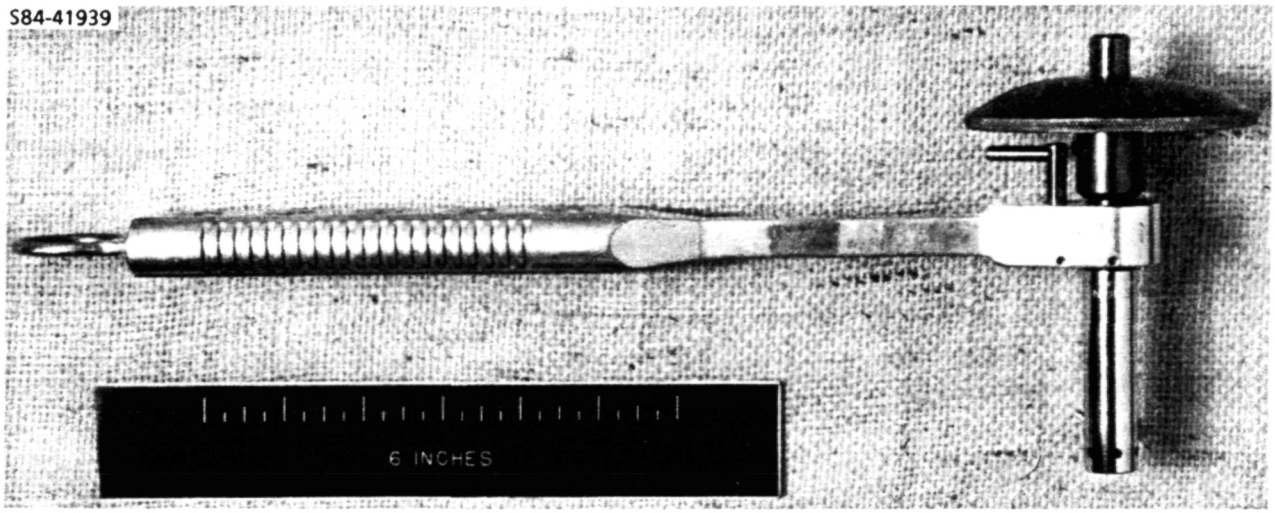
Technical Information	
Part number	10172-20530-01
Weight	1.18 lb
Material/ construction	Aluminum, tether ring on handle Grooved handle with holes
Temperature range	-100° to 200° F
Availability	Flight specific

Dimensional Data	
A	10.50 in.
B	3.50 in.
C	7.12 in.
D	1.50 in.
E	0.75 in.
F	4.06 in.
G	1.75 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

3/8-INCH DRIVE RATCHET, EVA WITH 7/16-INCH HEX SOCKET



OVERVIEW

The EVA 3/8-inch drive ratchet with 7/16-inch hex socket is a specially designed tool for EVA use. A deep-well, 7/16-inch hex socket is stowed attached to the 3/8-inch drive. The tool allows continuous ratcheting in both the clockwise and counterclockwise directions. It is equipped with a lever for selection of drive direction and a palm wheel for fast, easy use during tightening or loosening. A tether ring is attached to the handle.

OPERATIONAL COMMENTS

The EVA 3/8-inch drive ratchet with 7/16-inch hex socket can be used on any accessible 7/16-inch bolt or nut. It was originally designed to extend the aft frame tilt actuator (AFTA) of the inertial upper stage (IUS) manually. This tool, also called the IUS socket wrench, is flown with IUS payloads.

A button on top of the palm wheel can be depressed with a pointed object to release the socket. A collar around the button prevents inadvertent socket release.

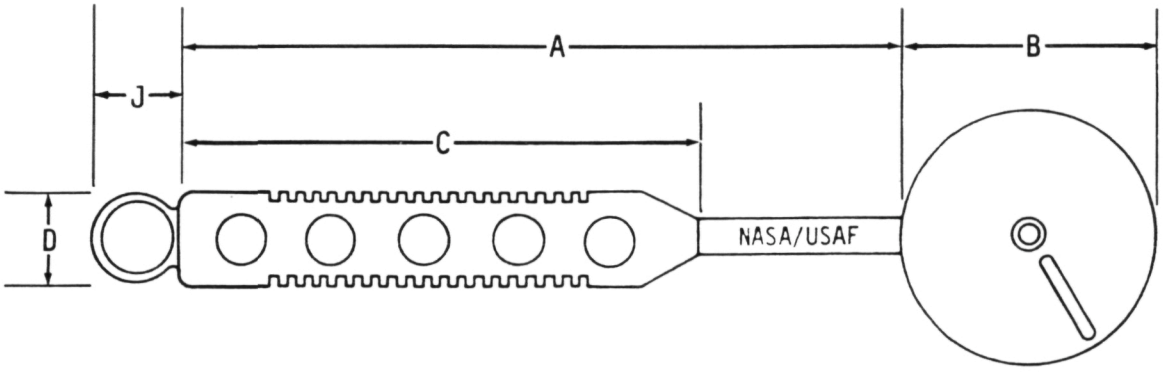
CONTACTS

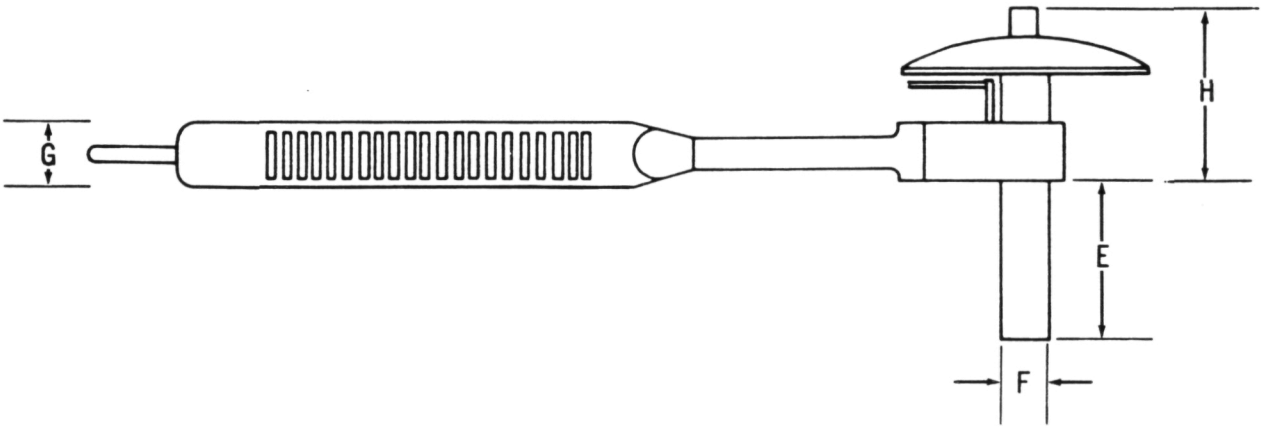
Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: R. J. Marak, NASA/EC5, (713) 483-9144

3/8-INCH DRIVE RATCHET, EVA WITH 7/16-INCH HEX SOCKET

Technical Information	
Part number	Wrench ESEX-82-27-10 Socket 47-61-21-2
Weight	1.251 lb
Material	Drive housing - aluminum Drive and socket - tool steel
Socket depth	2.0 in.
Design temperature range	-100° to 200° F
Availability	Flight specific

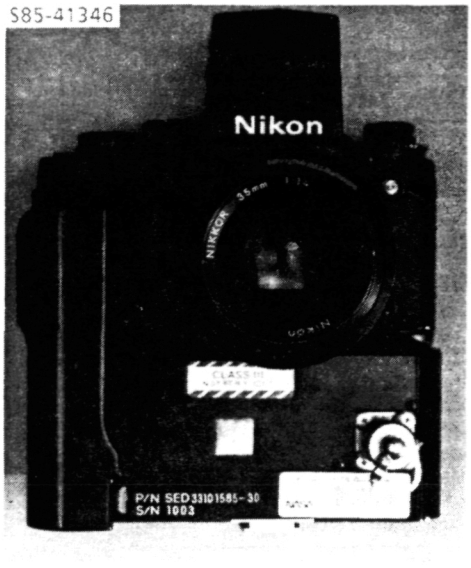
Dimensional Data	
A	10.25 in.
B	3.50 in.
C	7.18 in.
D	1.50 in.
E	2.60 in.
F	0.65 in.
G	0.75 in.
H	2.78 in
J	1.50 in.





ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

35-mm CAMERA



OVERVIEW

The 35-mm camera used in EVA's is a specially modified Nikon F3HP single lens reflex with titanium housing. The EVA camera has a permanently attached motor drive, film capacity of up to 72 exposures, a fuse-protected power supply, hermetically sealed battery compartment, and specially tested electronics.

OPERATIONAL COMMENTS

The 35-mm camera requires a special long-eye viewfinder with large exit pupil for use in EVA. An EVA kit provides tab extenders to allow operation of the shutter release and focus and aperture rings with EMU gloves. Three databacks are available to imprint different combinations of time, date, and frame number on film as photos are taken. An ultraviolet filter is used to reduce the film's excessive blue response to ultraviolet (UV) radiation. Special EVA film, Ektachrome 64 with 65 exposures, is also used. The camera is protected for EVA use by a special thermal cover.

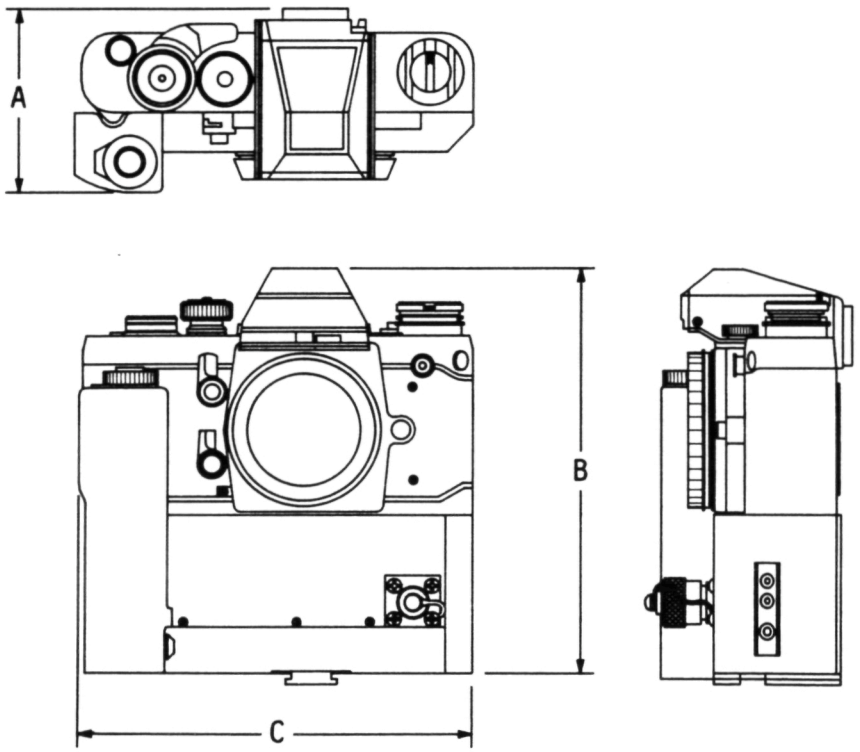
CONTACTS

Operational: J. M. Bremer, NASA/DF4, (713) 483-2585
Technical: J. Ragan, NASA/SP4, (713) 483-3646
Source: J. Regan, NASA/SP4, (713) 483-3646

35-mm CAMERA

Technical Information	
Part number	SED33101585-302, modified 35-mm Nikon F3HP
Weight	3.2 lb, body only
Viewfinder	SED33101574-301, long-eye, large exit pupil
Battery pack	SED33101573-301
EVA kit	SED33102478-301, tab extenders for focus, aperture and shutter release
Databack	SED33101588-302, year-month-day or hours-minutes-seconds or frame number SED33101588-303, year-month-day or days-hours-minutes or frame number SED33101588-304, year-month-day or hours-minutes-seconds or frame number (vertically between frames)
35-mm lens	SED33101579-302, mild wide angle, little distortion
28-mm lens	SED33101583-302, medium wide angle, moderate distortion
16-mm lens	SED33103387-301, very wide angle
Stowage	Middeck locker
Availability	Camera - standard, EVA kit - flight specific

Dimensional Data	
A	2.89 in.
B	6.55 in.
C	5.97 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

35-mm CAMERA COVER

OVERVIEW

The 35-mm camera cover is a thermal insulation garment which encases the 35-mm camera when used for EVA.

OPERATIONAL COMMENTS

The multilayer insulation cover uses 12 layers of aluminized mylar film as the prime insulation material. The shell is Teflon fabric on the inside and Ortho fabric on the outside. It conforms to the camera shape by means of many flaps which overlap and are secured by Velcro tape. The cover is stowed in a middeck camera bag for scheduled EVA missions.

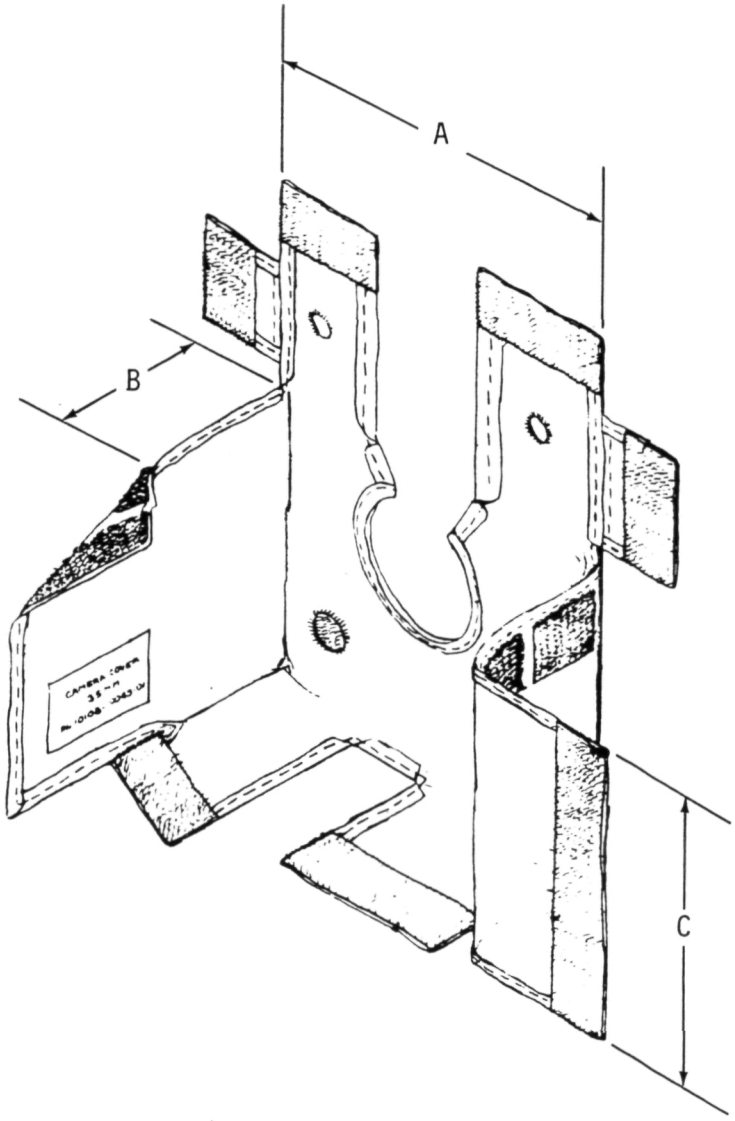
CONTACTS

Operational: J. M. Bremer, NASA/DF4, (713) 483-2585
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

35-mm CAMERA COVER

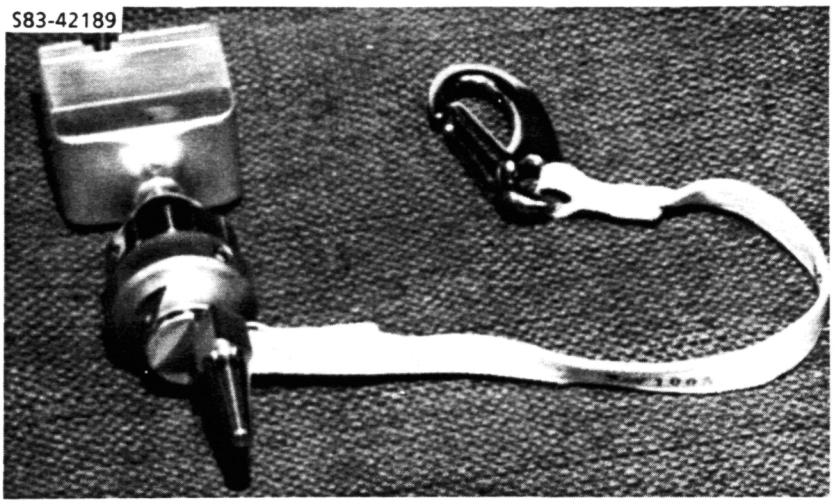
Technical Information	
Part number	10108-10043-01
Weight	0.35 lb
Material	Ortho, Teflon, aluminized mylar, polyester scrim
Stowage	Middeck locker
Availability	Flight specific

Dimensional Data	
A	6.50 in.
B	2.25 in.
C	6.00 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

35-mm CAMERA MOUNT



OVERVIEW

The 35-mm camera mount is used to attach a 35-mm camera to the mini work station (MWS).

OPERATIONAL COMMENTS

The 35-mm camera mount attaches to the MWS by means of an interface adapter pin inserted in a socket on the MWS. This same MWS socket also accommodates a tool caddy. A strap assembly with snap hook extends from the mount to be secured to the work station crossbar.

The 35-mm camera has a male bottom fitting that slides into place on the camera mount and is secured by engaging a pushbutton lock. The mount pedestal supports the camera at a height that allows the crewmember to see through the viewfinder. The crewmember can position the camera at the desired orientation by manipulating the ball socket of the mount pedestal.

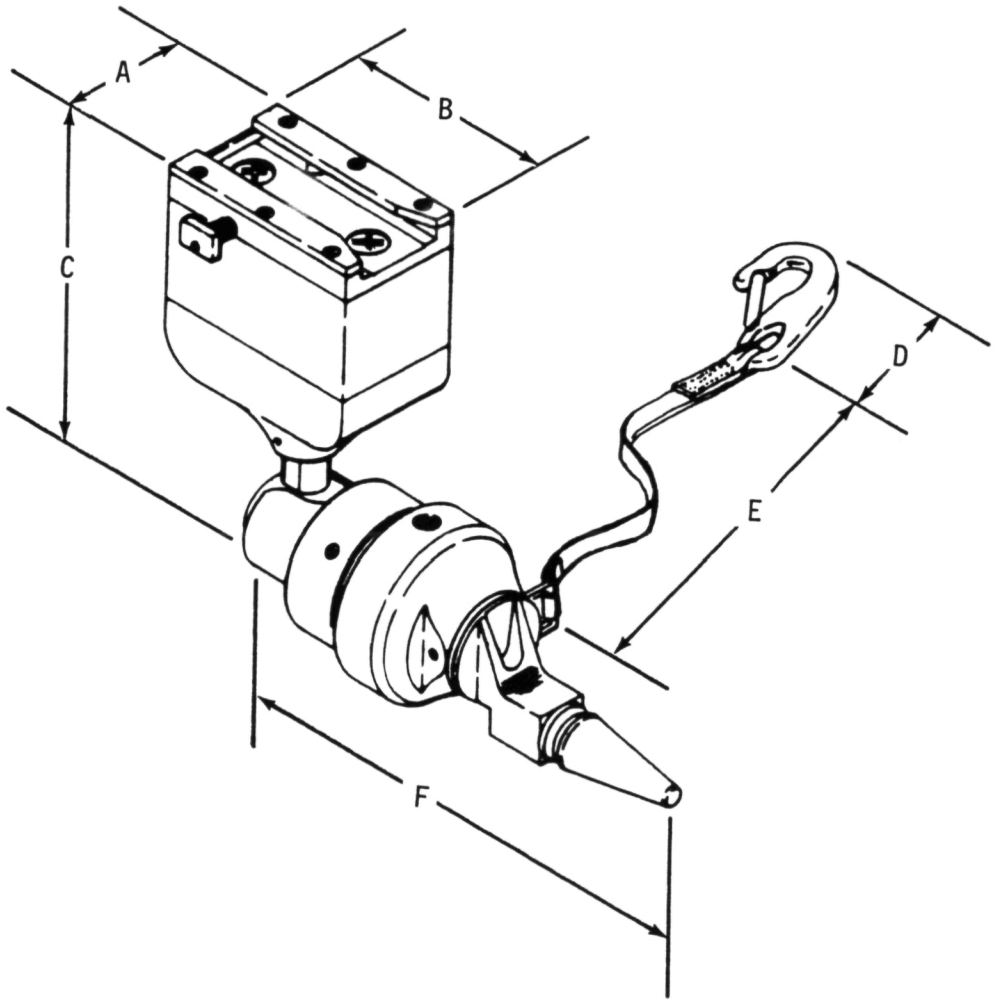
CONTACTS

Operational: J. M. Bremer, NASA/DF4, (713) 483-2585
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

35-mm CAMERA MOUNT

Technical Information	
Part number	10159-10009-02
Weight	1.04 lb
Material	Aluminum, stainless steel
Quantity flown	One as required
Stowage	Middeck locker
Availability	Flight specific

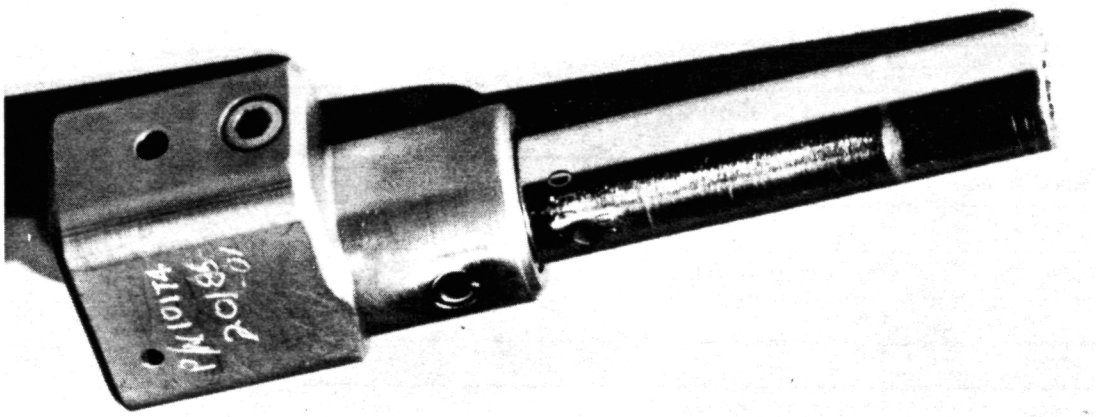
Dimensional Data	
A	1.19 in.
B	2.04 in.
C	2.76 in.
D	2.38 in.
E	12.00 in. true length
F	4.50 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

5/16-INCH HEX SOCKET FOR 3/8-INCH DRIVE

S85-40833



OVERVIEW

The 5/16-inch hex socket for 3/8-inch-drive is attached to a drop-proof tether by an adapter and two spring pins. The extension is a commercially available socket modified for EVA use. One side of the drop-proof tether is Velcro-covered to allow attachment to a Velcro surface during use.

OPERATIONAL COMMENTS

The 5/16-inch hex socket for the 3/8-inch drive can be used on a variety of hand and power tools which have drop-proof tether attachments. The 5/16-inch hex socket fits the manned maneuvering unit (MMU) launch bolts and was used on the STS 51-A satellite retrieval mission. A quick release pin is used to connect the socket to and disconnect it from the 3/8-inch-drive tools.

CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

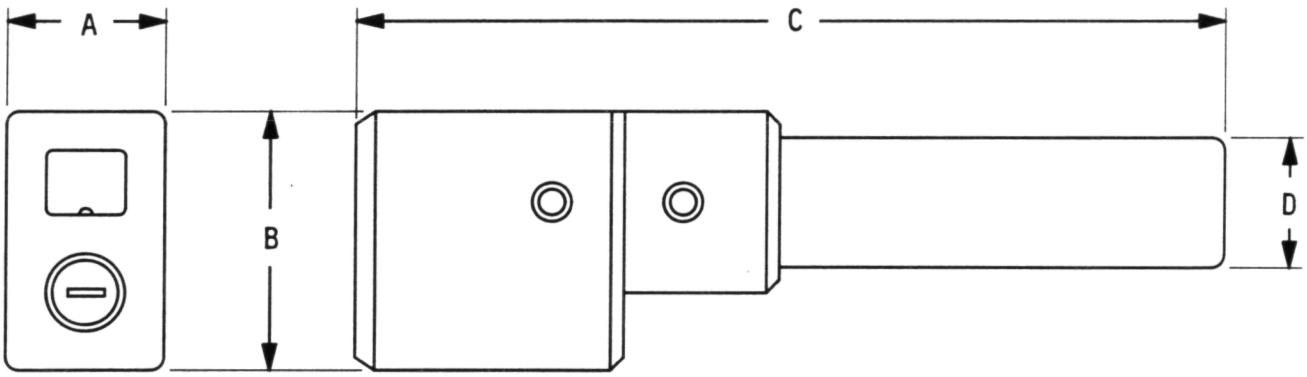
PRECEDING PAGE BLANK NOT FILMED

Section 4
PAGE ___ INTENTIONALLY BLANK

5/16-INCH HEX SOCKET FOR 3/8-INCH DRIVE

Technical Information	
Part number	10174-20185-01
Weight	0.27 lb
Material	Socket - chrome-plated steel Drop-proof tether - stainless steel
Socket depth	1.81 in.
Quantity flown	One
Stowage	Crew compartment
Availability	Flight specific

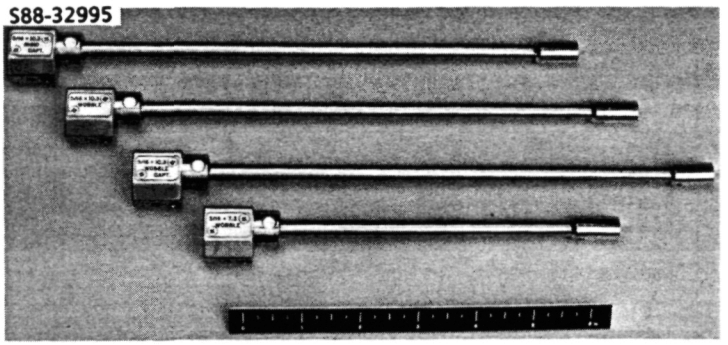
Dimensional Data	
A	0.70 in.
B	1.01 in.
C	3.67 in.
D	0.50 in.



204660019.ART, 3

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

5/16-INCH HEX SOCKET FOR 3/8-INCH DRIVE (HST)



OVERVIEW

Each of the 5/16-inch hex sockets for 3/8-inch drive is designed for use on the Hubble Space Telescope (HST) maintenance and repair missions. Each tool has a 12-point socket attached to a shaft with a 3/8-inch drop-proof tether. Capture pins are used to secure the socket and drop-proof tether to the shaft. Each shaft and socket has engraved rotation marks which act as a guide to counting revolutions.

OPERATIONAL COMMENTS

The 10.3-inch rigid capture tool (10181-10004-01) has a 9-inch solid shaft. The internal snap ring capture device secures the fastener in the tool's socket so that it will be easier for the crewmember to control. The crewmember places the tool over the fastener and pushes it so that the fastener is captured in the internal snap ring device. The capture sockets are chrome plated prior to the installation of the capture ring. The capture feature is specifically designed to work on HST 5/16-inch hex screws and may not function with other hexes having more rounded corners.

The 10.3-inch wobble capture tool (10181-10005-01) has a 9-inch shaft and 5° half angle self-centering wobble feature which aids the suited crewmember when installing or removing hex screws in a limited access area. This tool also incorporates the internal snap ring for fastener capture.

The 7.3-inch wobble non-capture tool (10181-10006-01) has a 5-inch shaft, and the 10.3-inch wobble non-capture tool (10181-10006-02) has a 9-inch shaft. Each incorporates the 5° half angle self-centering wobble feature for ease of access.

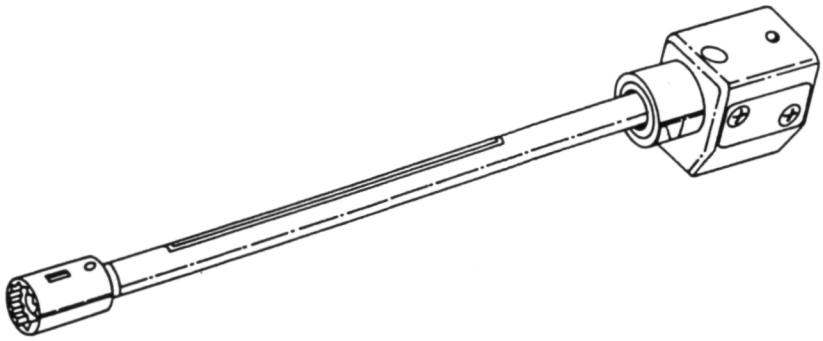
CONTACTS

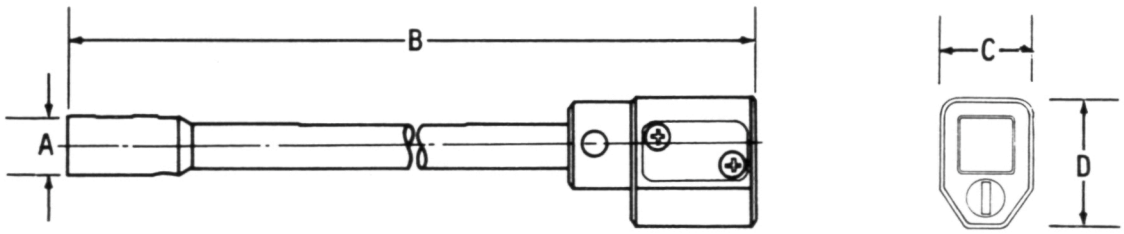
Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

5/16-INCH HEX SOCKET FOR 3/8-INCH DRIVE (HST)

Technical Information		
Part number	10181-10004-01 10181-10005-01 10181-10006-01 10181-10006-02	Rigid, capture, 10.3 in. Wobble, capture, 10.3 in. Wobble, non-capture, 7.3 in. Wobble, non-capture, 10.3 in.
Weight	10181-10004-01 10181-10005-01 10181-10006-01 10181-10006-02	0.33 lb 0.32 lb 0.26 lb 0.32 lb
Material/ construction	Stainless steel	
Temperature range	-150° to +250° F	
Socket depth	10181-10004-01 10181-10005-01 10181-10006-01 10181-10006-02	0.146 in. 0.146 in. 0.235 in. 0.235 in.
Force/torque	10181-10004-01 10181-10005-01 10181-10006-01 10181-10006-02	151.0 in-lb 139.0 in-lb 139.0 in-lb 139.0 in-lb
Availability	Flight specific	

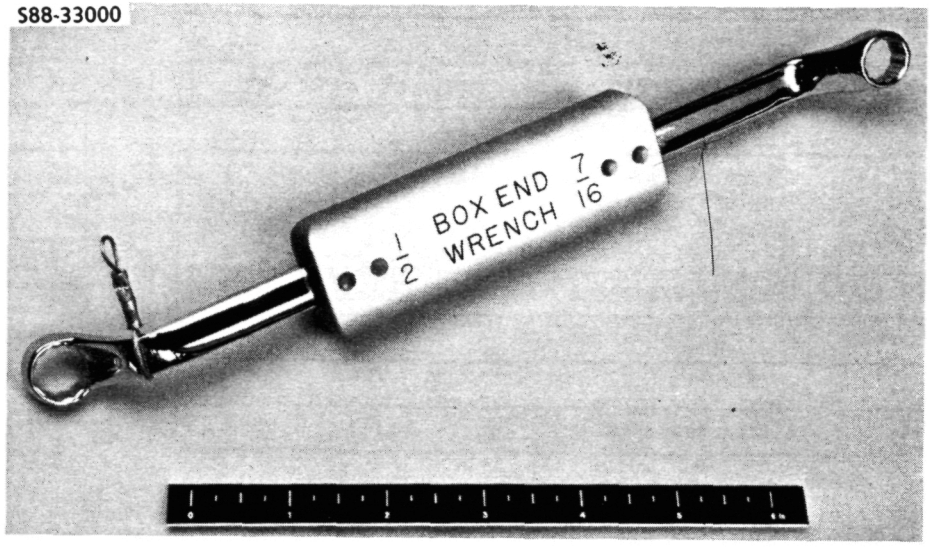
Dimensional Data	
A	0.441 in.
B	10.300 in.(10004)
	10.300 in.(10005)
	7.300 in.(10006-01)
	10.300 in.(10006-01)
C	0.660 in.
D	0.930 in.





ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

7/16-INCH AND 1/2-INCH BOX END WRENCH



OVERVIEW

The 7/16-inch and 1/2-inch box end wrench has a standard 12-point, 1/2-inch box end wrench and a standard 12-point, 7/16-inch box end wrench combined into one tool.

OPERATIONAL COMMENTS

The 7/16-inch and 1/2-inch box end wrench is designed for use on Hubble Space Telescope (HST) maintenance and repair missions. It is a standard tool modified with an EVA-glove-compatible handle.

CONTACTS

Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

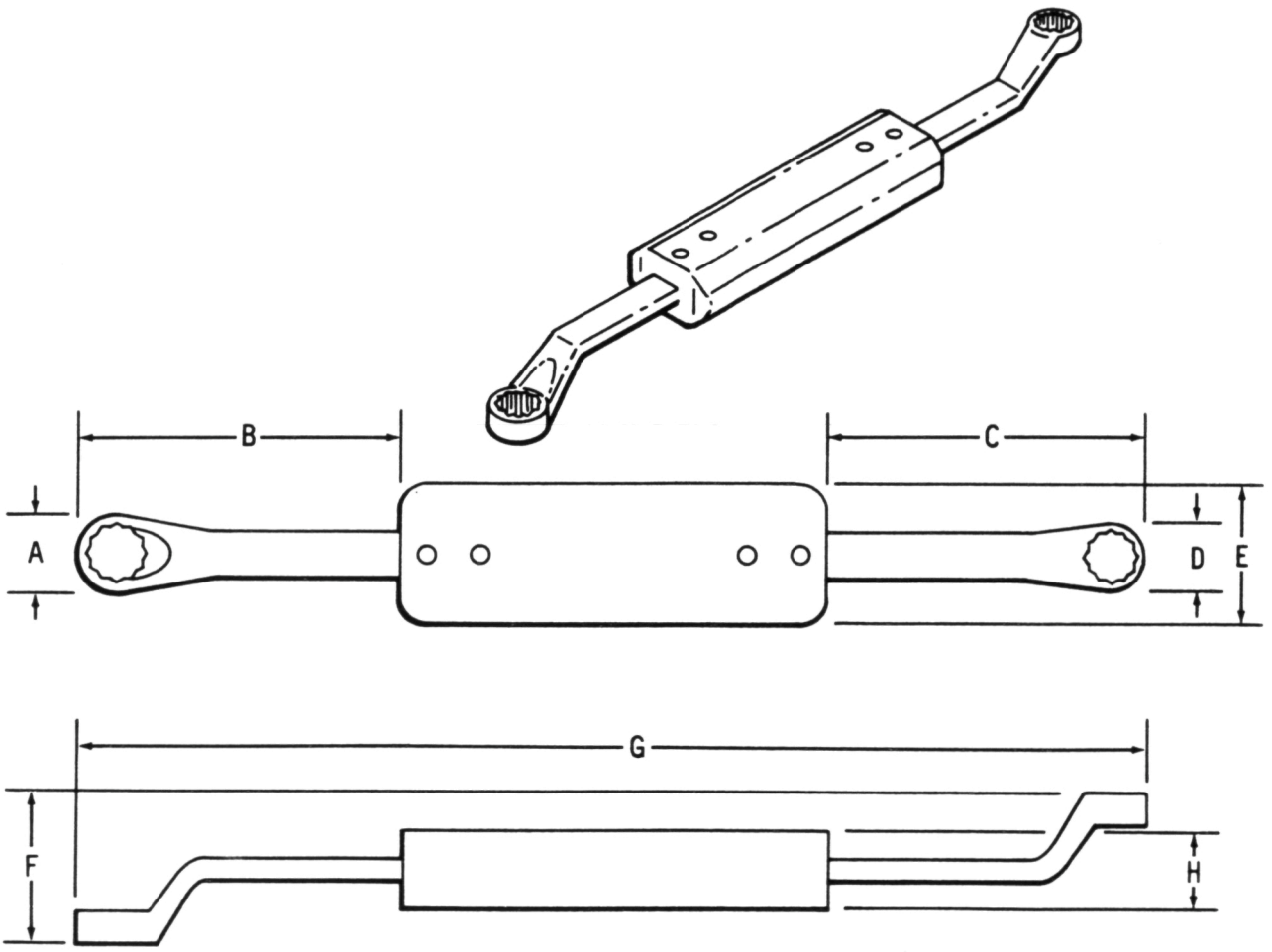
PRECEDING PAGE BLANK NOT FILMED

Section 6
PAGE INTENTIONALLY BLANK

7/16-INCH AND 1/2-INCH BOX END WRENCH

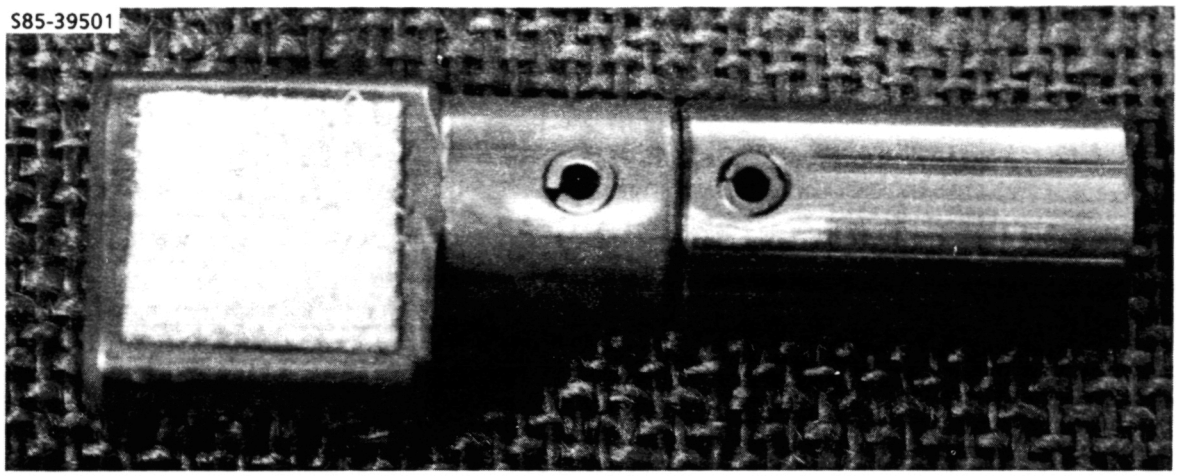
Technical Information	
Part number	10181-10022-01
Weight	0.55 lb
Material/ construction	Wrench ends: stainless steel Handle: aluminum
Temperature range	-150° to +250° F
Availability	Flight specific

Dimensional Data	
A	0.75 in.
B	3.00 in.
C	3.00 in.
D	0.69 in.
E	1.38 in.
F	1.35 in.
G	10.00 in.
H	0.75 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

7/16-INCH HEX SOCKET EXTENSION FOR 3/8-INCH DRIVE



OVERVIEW

The 7/16-inch hex socket extension for 3/8-inch-drive is attached to a drop-proof tether by an adapter and two spring pins. One side of the drop-proof tether is Velcro-covered to allow attachment to a tool caddy.

OPERATIONAL COMMENTS

The 7/16-inch hex socket extension can be used on a variety of hand and power tools that have drop-proof tether attachments. The socket assembly may be stowed in a Velcro-lined tool caddy or on a manipulator foot restraint (MFR) tool board. A quick-release pin is used for connecting and disconnecting the socket from the 3/8-inch-drive tools.

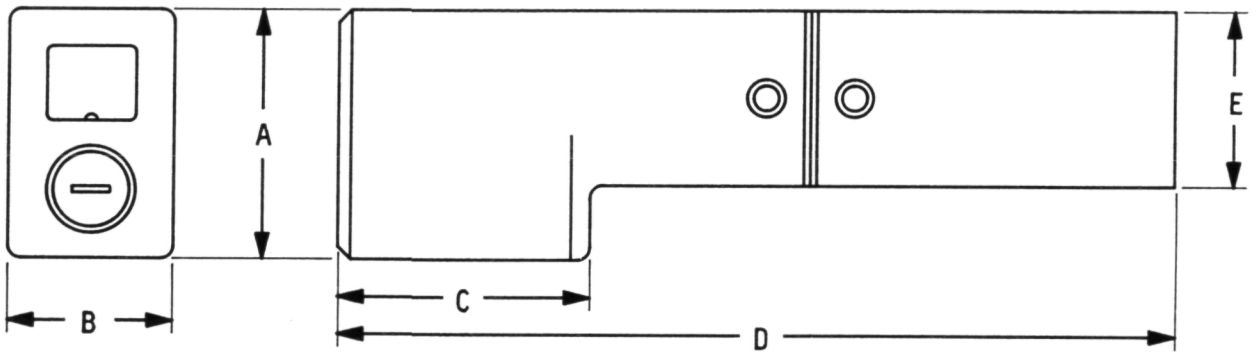
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

7/16-INCH HEX SOCKET EXTENSION FOR 3/8-INCH DRIVE

Technical Information	
Part number	10172-20552-01
Weight	0.31 lb
Material	Sleeve - stainless steel Adapter - stainless steel Drop-proof tether - stainless steel Velcro - hook
Socket depth	0.85 in.
Availability	Flight specific

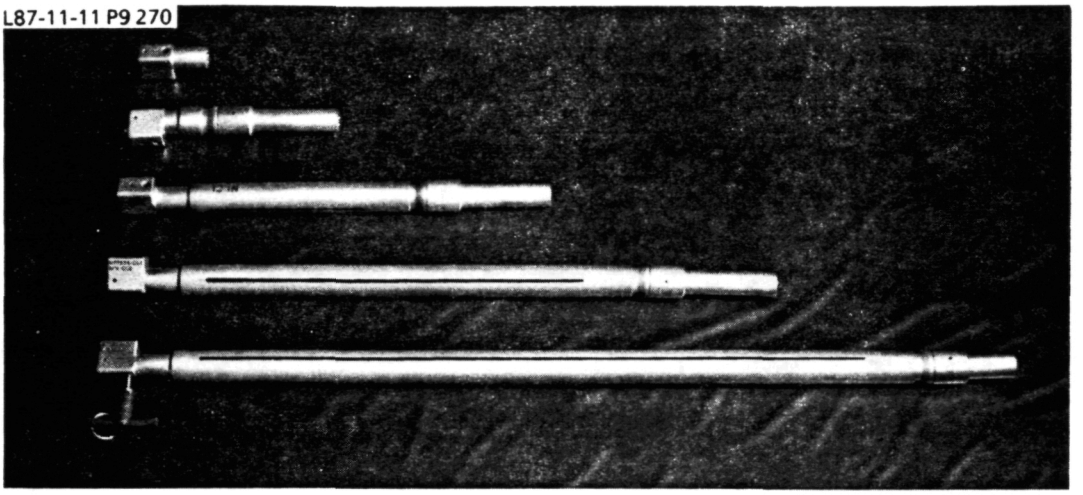
Dimensional Data	
A	1.000 in.
B	0.700 in.
C	0.875 in.
D	3.030 in.
E	0.700 in.



204660020.ART, 3

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

7/16-INCH HEX SOCKET EXTENSION FOR 3/8-INCH DRIVE (HST)



OVERVIEW

The 7/16-inch hex socket extension for 3/8-inch drive for the Hubble Space Telescope (HST) comes in five different lengths: 2 inches, 6 inches, 12 inches, 18 inches, and 24 inches. Each one has a 12-point, 7/16-inch socket pinned to the end. All of the extensions, except the 2-inch, have an internal wobble alignment of 32° full angle. This feature has a self-aligning device which assures that the extension and socket will return to center. All extensions have drop-proof tethers.

OPERATIONAL COMMENTS

The 7/16-inch hex socket extensions are intended for use with any drive tool equipped with a drop-proof tether interface. The drop-proof tether requires that the pin be inserted before the drive tool can be attached. When the pin is pulled out, the drive will be locked into the extension until the pin is inserted again. This set of extensions is created for use during an HST maintenance mission.

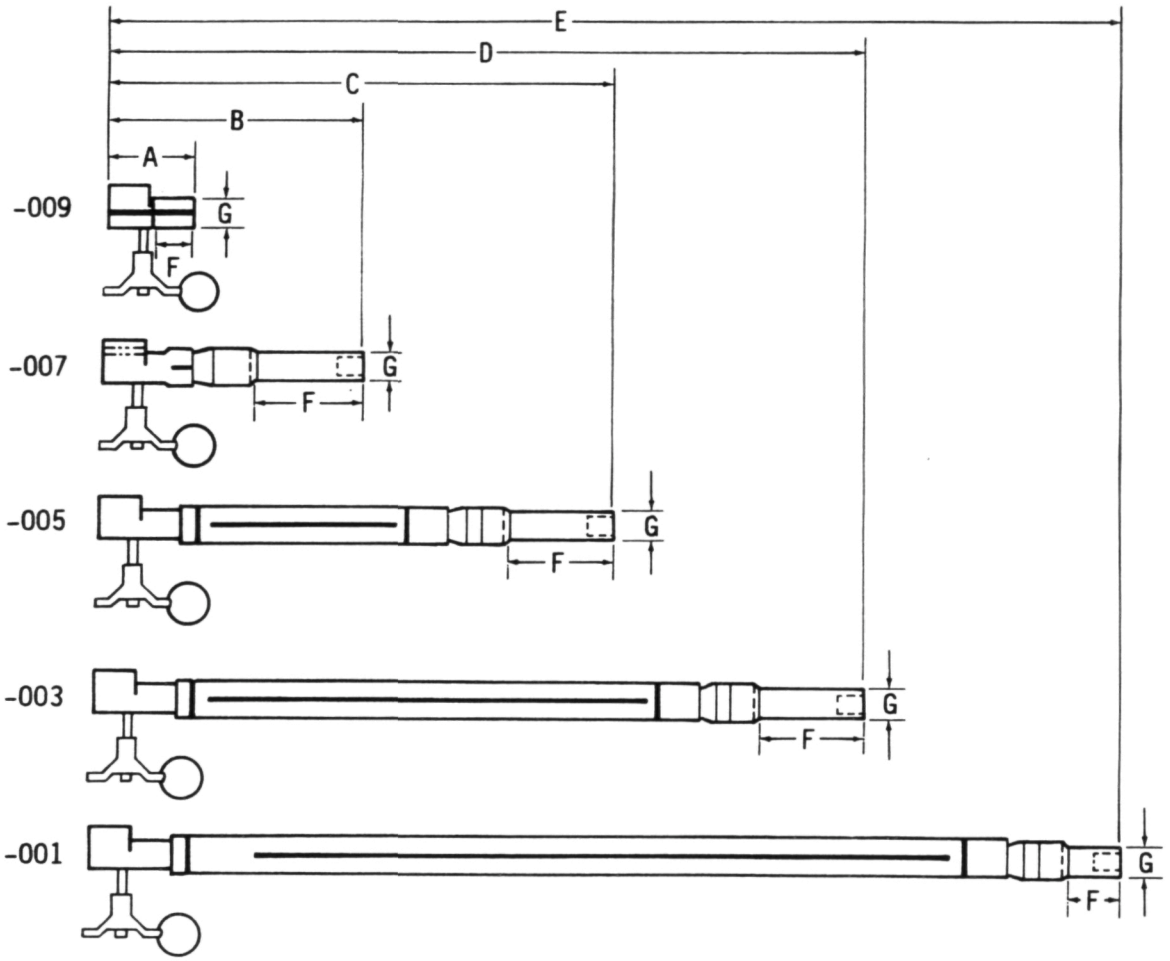
CONTACTS

Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. Sheffield LMSC/Dept. 64-10, (408) 742-8464
Source: LMSC, HST Contracts Office, (408) 742-5505

7/16-INCH HEX SOCKET EXTENSION FOR 3/8-INCH DRIVE (HST)

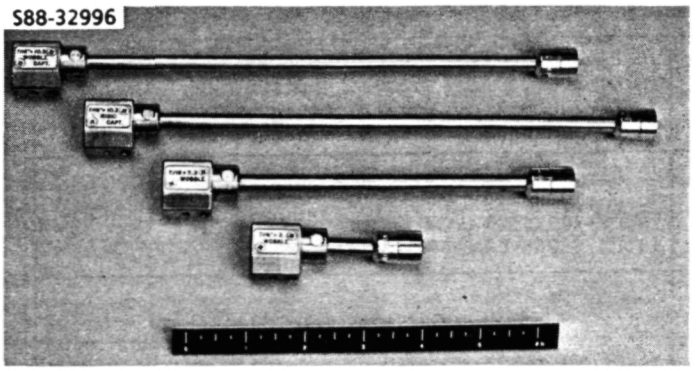
Technical Information	
Part number	2.0 in. - 4177656-009 6.0 in. - 4177656-007 12.0 in. - 4177656-005 18.0 in. - 4177656-003 24.0 in. - 4177656-001
Weight	2.0 in. - 0.22 lb 6.0 in. - 0.64 lb 12.0 in. - 1.00 lb 18.0 in. - 2.28 lb 24.0 in. - 2.53 lb
Material/ construction	Stainless steel 15-5 PH CRES
Temperature range	-200° to +250° F
Proof Load	70 ft-lb
Socket depth	0.62 in.
Availability	Flight specific

Dimensional Data		
A	2.0 in.	
B	6.0 in	
C	12.0 in.	
D	18.0 in.	
E	24.0 in.	
F	-001	1.250 in.
	-003 -005 -007	2.125 in.
	-009	1.000 in.
G	0.68 in.	



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

7/16-INCH HEX SOCKET FOR 3/8-INCH DRIVE (HST)



OVERVIEW

Each of the 7/16-inch hex sockets for 3/8-inch drive is designed for use on the Hubble Space Telescope (HST) maintenance and repair missions. Each tool has a 12-point socket attached to a shaft with a 3/8-inch drop-proof tether. Capture pins are used to secure the socket and drop-proof tether to the shaft. Each shaft and socket has engraved rotation marks which act as a guide to counting revolutions.

OPERATIONAL COMMENTS

The 10.3-inch rigid capture tool (10181-10007-01) has a 9-inch solid shaft. The internal snap ring capture device secures the fastener in the tool's socket so that it will be easier for the crewmember to control. The crewmember places the tool over the fastener and pushes it so that the fastener is captured in the internal snap ring device. The capture sockets are chrome plated prior to the installation of the capture ring. The capture feature is specifically designed to work on HST 7/16-inch hex screws and may not function on other hexes having more rounded corners.

The 10.3-inch wobble capture tool (10181-10008-01) has a 9-inch shaft and 5° half angle self-centering wobble feature which aids the suited crewmember when installing or removing hex screws in a limited access area. This tool also incorporates the internal snap ring for fastener capture.

The 3-inch wobble non-capture tool (10181-10025-01) has a 1.67-inch shaft and is sized for use with a torque limiter. The 7.3-inch wobble non-capture tool (10181-10025-02) has a 6-inch shaft. Each tool incorporates the 5° half angle self-centering wobble feature for ease of access.

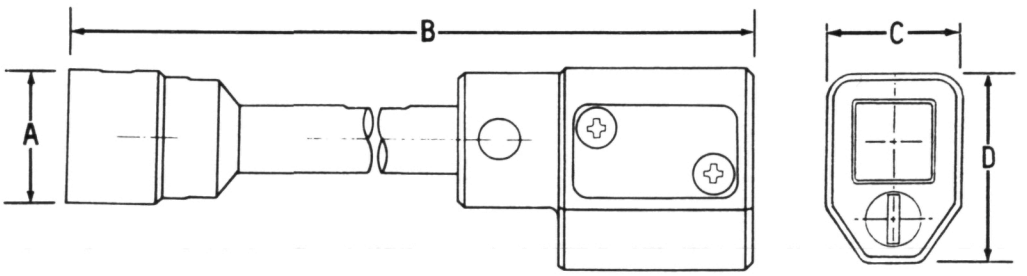
CONTACTS

Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

7/16-INCH HEX SOCKET FOR 3/8-INCH DRIVE (HST)

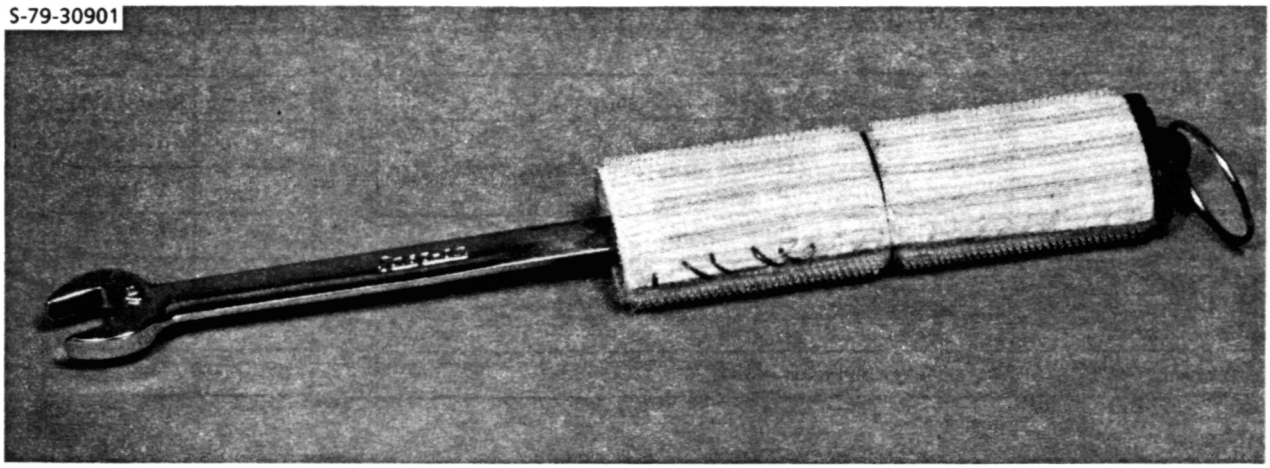
Technical Information		
Part number	10181-10007-01	Rigid, capture, 10.3 in.
	10181-10008-01	Wobble, capture, 10.3 in.
	10181-10025-01	Wobble, non-capture, 3.0 in.
	10181-10025-02	Wobble, non-capture, 7.3 in.
Weight	10181-10007-01	0.33 lb
	10181-10008-01	0.33 lb
	10181-10025-01	0.18 lb
	10181-10025-02	0.27 lb
Material/ construction	Stainless steel	
Temperature range	-150° to +250° F	
Socket depth	10181-10007-01	0.205 in.
	10181-10008-01	0.205 in.
	10181-10025-01	0.281 in.
	10181-10025-02	0.281 in.
Force/torque	10181-10007-01	317.0 in-lb
	10181-10008-01	139.0 in-lb
	10181-10025-01	139.0 in-lb
	10181-10025-02	139.0 in-lb
Availability	Flight specific	

Dimensional Data	
A	0.625 in.
B	10.33 in. (7-01) 10.33 in. (8-01) 3.00 in. (25-01) 7.30 in. (25-02)
C	0.66 in.
D	0.93 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

7/16-INCH OPEN END WRENCH



OVERVIEW

The 7/16-inch open end wrench is a common tool modified for EVA use. The handle is built up and wrapped with Velcro to provide easy gripping by the gloved hand. A tether ring is mounted on the end of the handle for tethering.

OPERATIONAL COMMENTS

The 7/16-inch open end wrench is a disconnect tool for EVA bolts with a 7/16-inch hex or square head. This tool is no longer part of the normally manifested EVA hardware because other 7/16-inch disconnect tools exist which are easier to operate.

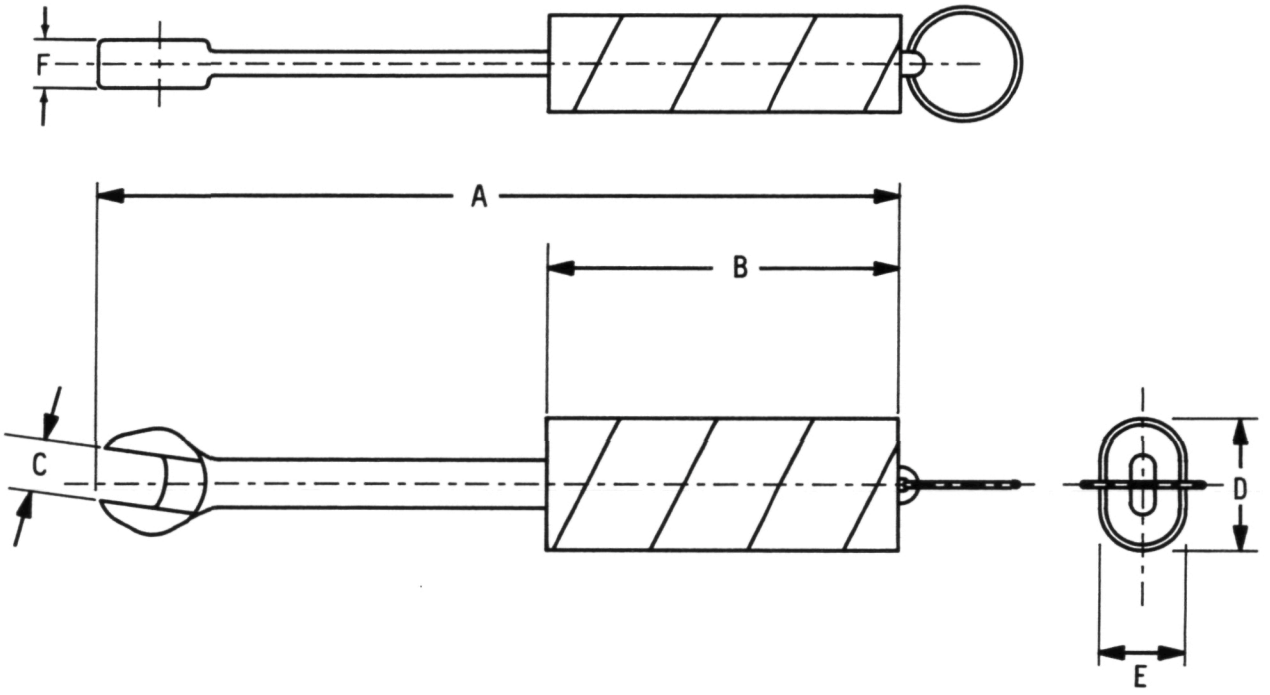
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: J. Madden, Rockwell/Houston, (713) 282-5300

7/16-INCH OPEN END WRENCH

Technical Information	
Part number	V628-650886
Weight	0.8 lb
Material/ construction	Wrench - AISI 4063 tool steel Handle - polyurethane, Velcro-wrapped, and tether ring
Temperature range	-200° to 250° F (operational)
Availability	Reference only

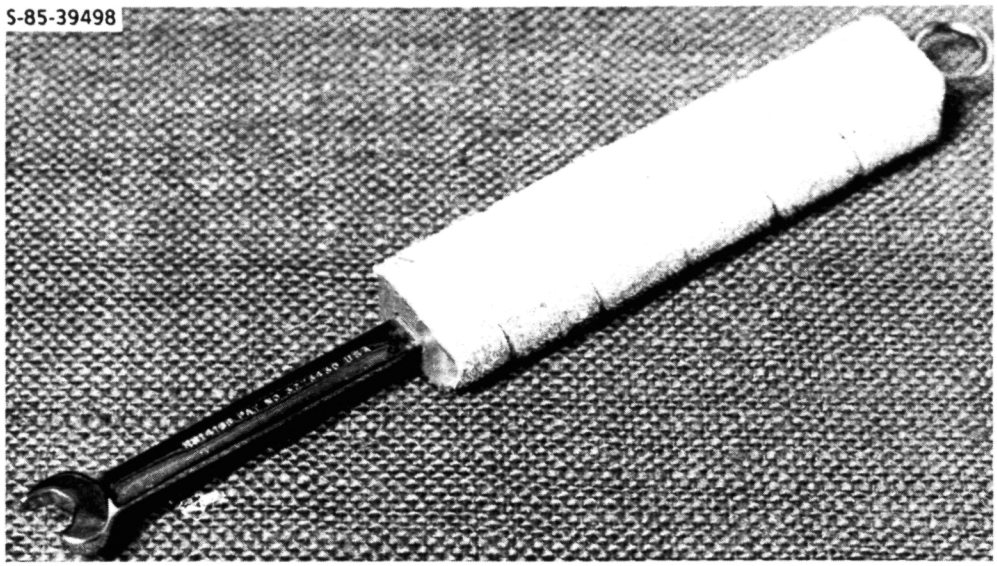
Dimensional Data	
A	9.00 in.
B	4.00 in.
C	0.44 in.
D	1.25 in.
E	0.75 in.
F	0.22 in.



204660026.ART, 2

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

7/16-INCH RATCHETING OPEN END WRENCH



OVERVIEW

The 7/16-inch ratcheting open end wrench is a commercially available tool modified for EVA use. The original wrench (10172-20515-01) has a Velcro-wrapped handle attached to the wrench by two dowel pins. A modified version (-02) created for Hubble Space Telescope (HST) use has no Velcro and includes lightening holes in the handle. Each handle includes a tether ring for restraint tethering during EVA.

OPERATIONAL COMMENTS

The ratcheting open end wrench is a contingency tool designed for loosening bolts without removing the wrench. The ratchet-link action allows for speed and easy access when clearance is limited. The head is set at a 15° angle. The -01 wrench was stowed in a tool caddy in the flight support system (FSS) locker for STS 41-C.

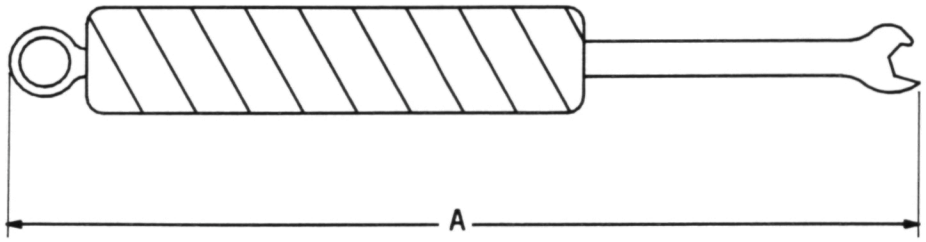
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

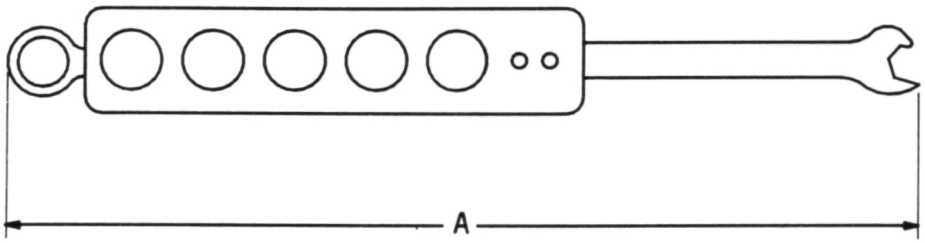
7/16-INCH RATCHETING OPEN END WRENCH

Technical Information	
Part number	10172-20515-01/02
Weight	0.51 lb (-01), 0.48 lb (-02)
Material	Wrench - chrome Handle - aluminum
Availability	Flight specific

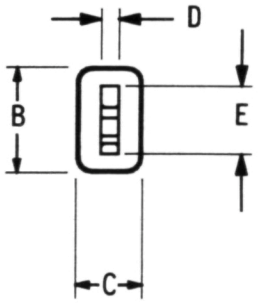
Dimensional Data	
A	11.00 in.
B	1.35 in.
C	0.78 in
D	0.22 in.
E	0.90 in.



-01



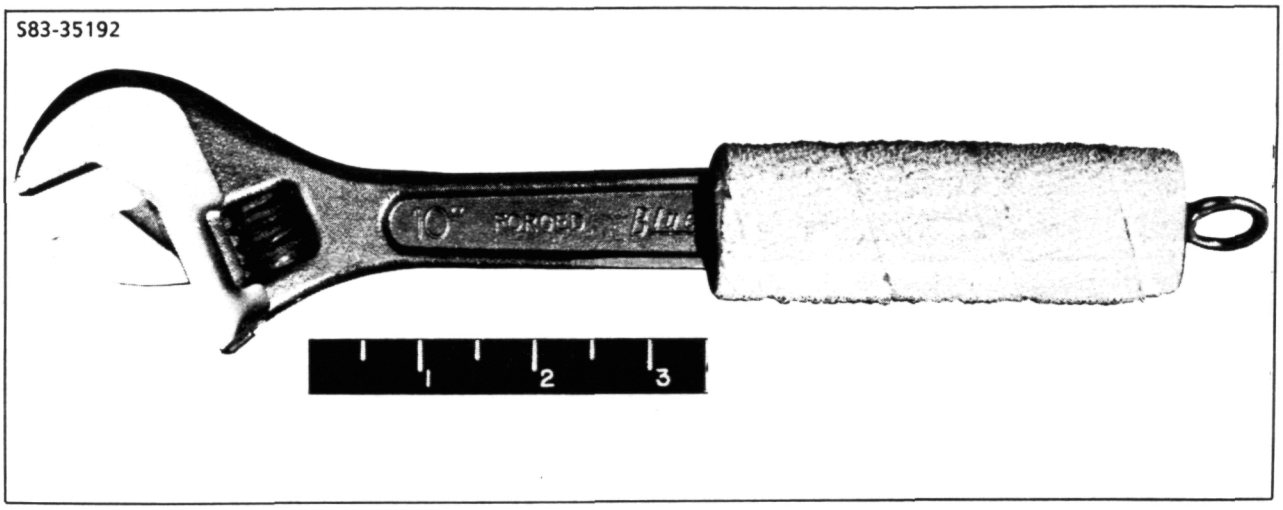
-02



204660027.ORT, 5

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

ADJUSTABLE WRENCH



OVERVIEW

The adjustable wrench is a common crescent wrench modified for EVA use. The handle is built up, wrapped with Velcro, and has a ring attached at the end for tethering. The adjustable jaws open to a maximum of 1-1/8 inches.

OPERATIONAL COMMENTS

The wrench can be used to hold, tighten, or loosen any square or hex nut or bolt with a head up to 1-1/8 inches across the flats.

It is a contingency tool used to manually force open failed latches on the airlock hatches in case of latch or rotary actuator jamming. The 3/8-inch drive ratchet with 7/16-inch socket is first used to remove the appropriate EVA removable bolt(s). The adjustable wrench is then used to force open the jammed latch and/or any latches disconnected from the rotary actuator.

Two separate wrenches are part of the normally manifested STS equipment. One is wrapped in a Velcro-lined tool caddy with the 3/8-inch drive ratchet with 7/16-inch hex socket extension and stowed in the starboard provisions stowage assembly (PSA). The second is stowed with the 3/8-inch drive ratchet with 7/16-inch hex socket in the EVA bag.

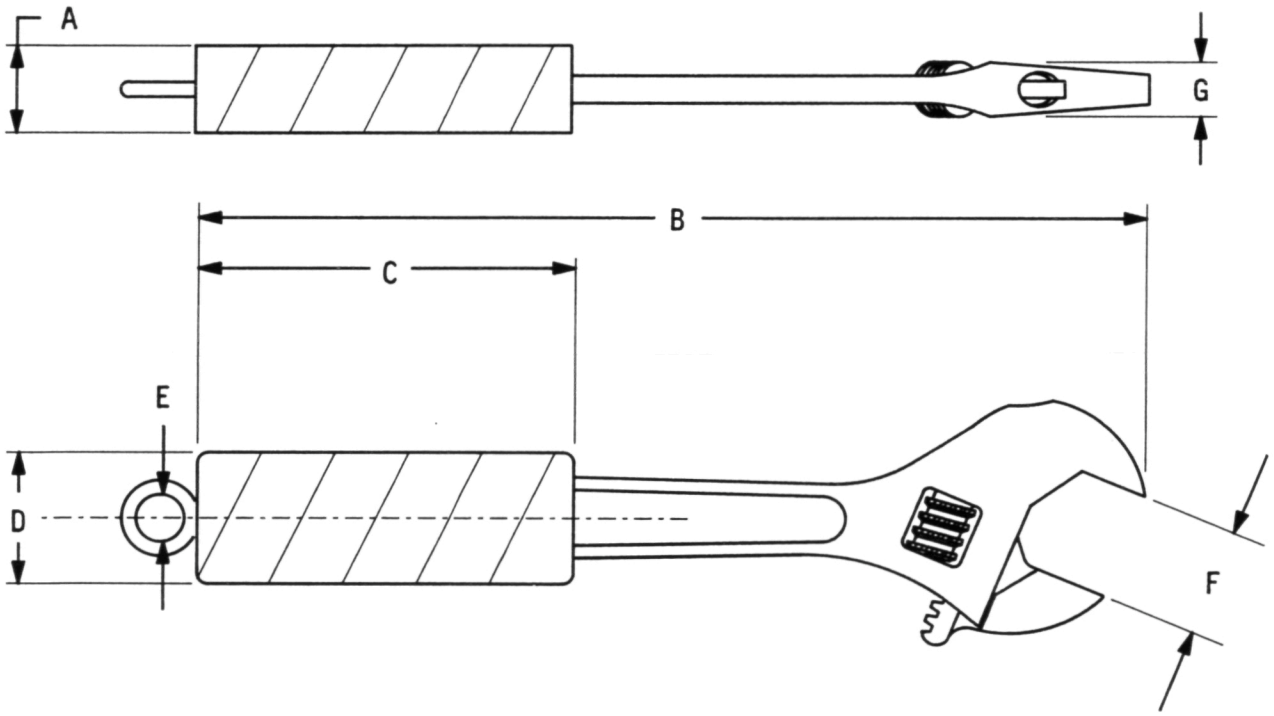
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: J. Madden, Rockwell/Houston, (713) 282-5300

ADJUSTABLE WRENCH

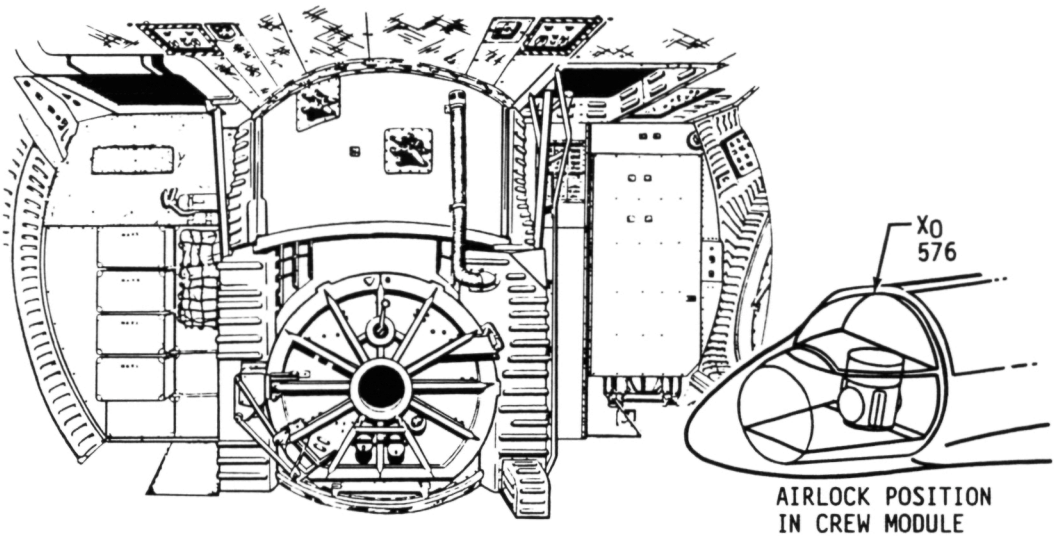
Technical Information	
Part number	V628-650892-004 or SDD33103431-301
Weight	0.99 lb
Material/ construction	Wrench - Snap-On Tool Co., chrome moly steel Handle - polyurethane, flat black, Velcro-wrapped Bonding - MB0130 - 136 adhesive Adj screw - lubricant - Molykote 321R
Adjustable jaws maximum opening	1-1/8 in.
Temperature range	-200° to 250° F (operational)
Quantity flown	One in the starboard PSA and one in the EVA bag
Availability	Standard

Dimensional Data	
A	0.750 in.
B	10.000 in.
C	4.000 in.
D	1.250 in.
E	0.670 in. max.
F	1.120 in.
G	0.563 in.



204660028.ART, 2

AIRLOCK



OVERVIEW

The primary purpose of the airlock is to eliminate the need for cabin decompression for EVA and to provide a means for transferring between the crew module and the Spacelab or payload bay. The baseline airlock location is inside the middeck compartment, allowing maximum use of cargo bay volume.

OPERATIONAL COMMENTS

In addition to being a compartment which can be depressurized and repressurized to accommodate EVA access to the payload bay, the airlock supports EVA preparation and post-EVA activities by providing

- Handholds and restraints for crewmember translation and position maintenance in zero gravity.
- Displays and controls for all airlock functions.
- Mounting provisions for up to three extravehicular mobility units (EMU's). Two-EMU stowage is standard.
- Two umbilicals for EMU servicing. Each umbilical provides cooling water, high pressure oxygen, power for battery recharge, power for EMU operation, and hardline communication.

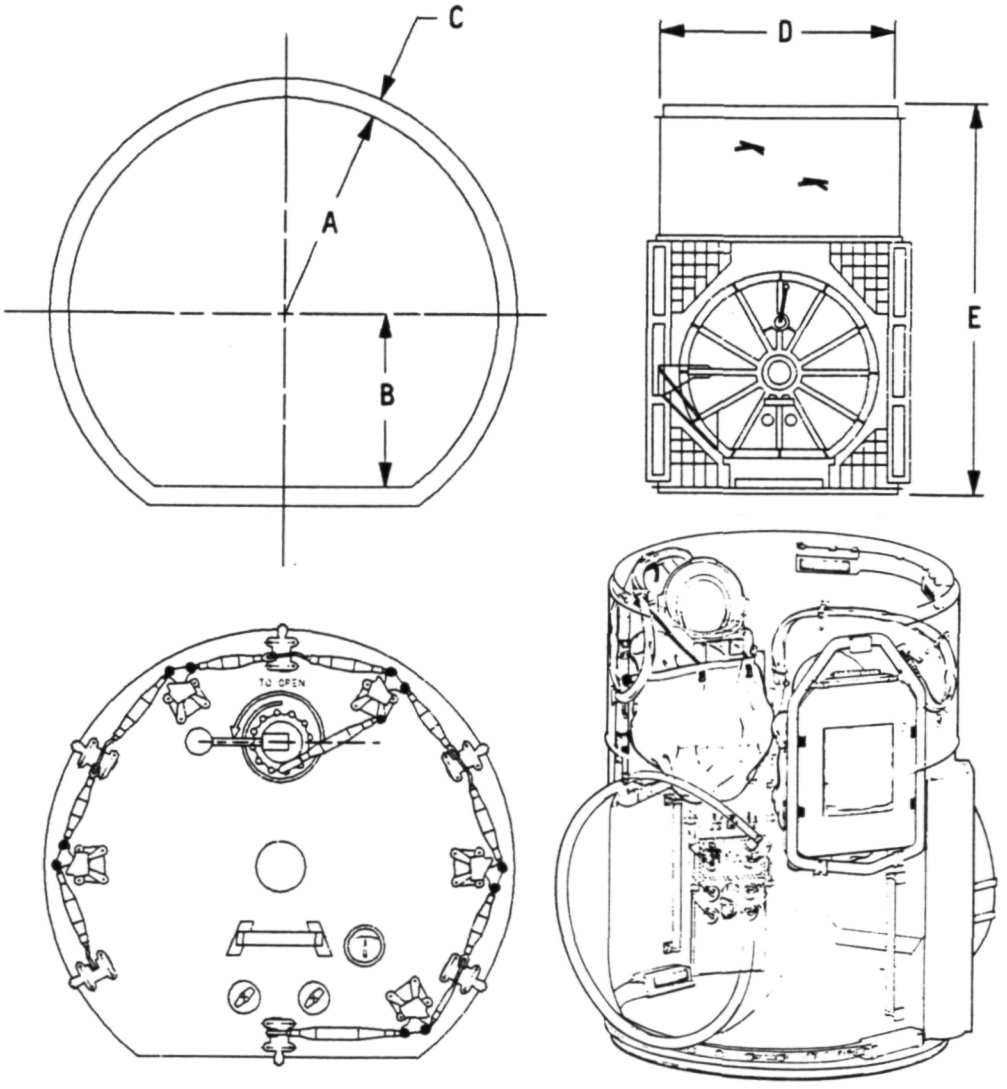
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483-2589
Technical: H. A. Rotter, NASA/EC6, (713) 483-9249
Source: Rockwell International

AIRLOCK

Technical Information	
Part number	Not applicable
Weight	825 lb (empty total), 72 lb (per hatch)
Internal free volume	150 ft^3 (no EMU's) 130 ft^3 (2 EMU's) 120 ft^3 (3 EMU's)
Wall hang-weight limit	300 lb maximum
Usable umbilical length	10 ft
Availability	Standard

Dimensional Data	
A	20.00 in.
B	16.00 in.
C	1.75 in.
D	63.00 in. (ID)
E	83.00 in.



204660185.ART, 1

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

AIRLOCK STOWAGE BAG

OVERVIEW

The airlock stowage bag is a Nomex bag used to store and transfer items used in EVA preparation activities. When in use, it may be attached inside the airlock over the inner hatch by Velcro straps and adjustable straps with small snap hooks. The airlock bag has labeled, elasticized pockets of various sizes with Velcro strap closures.

OPERATIONAL COMMENTS

The airlock bag is arranged such that all of each crewmember's personal items are on one side of the airlock and within reach after the crewmember dons the upper torso of the extravehicular mobility unit (EMU). The back of the airlock bag has several large pockets for stowing additional equipment. Two pip pins are attached to the bag so that it may be mounted on the forward middeck lockers if desired. This bag and its contents are removed from the airlock prior to depress to vacuum.

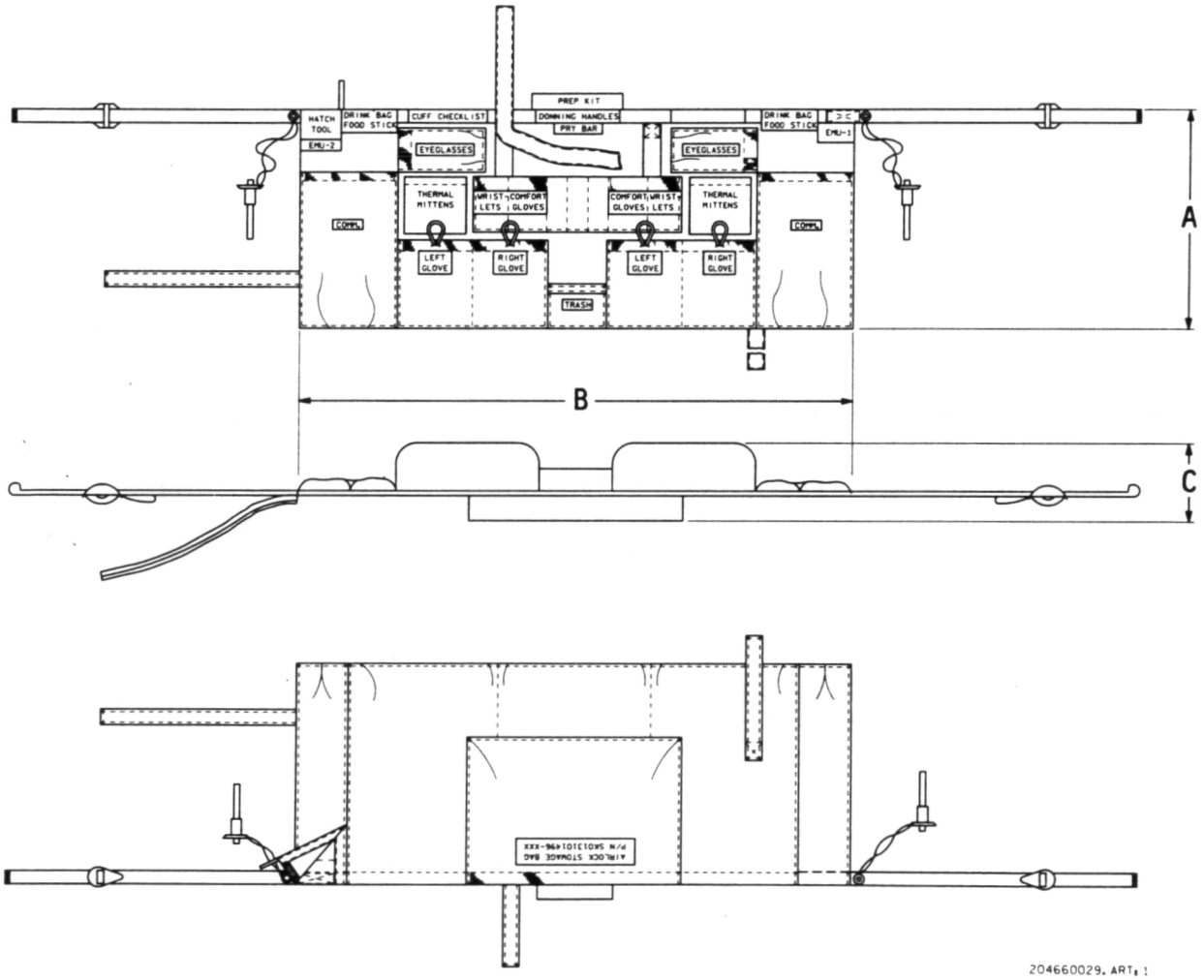
CONTACTS

Operational: C. H. Armstrong, NASA/DF42, (713) 483-2588
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

AIRLOCK STOWAGE BAG

Technical Information	
Part number	SKD13101496-306
Weight	1.77 lb
Material	Nomex
Contents during launch	Two pairs of EV glasses (if required), one EMU prep kit, donning handles, two drink bags, one drink bag syringe, and one pry bar
Quantity flown	One
Stowage	Volume H locker
Availability	Standard

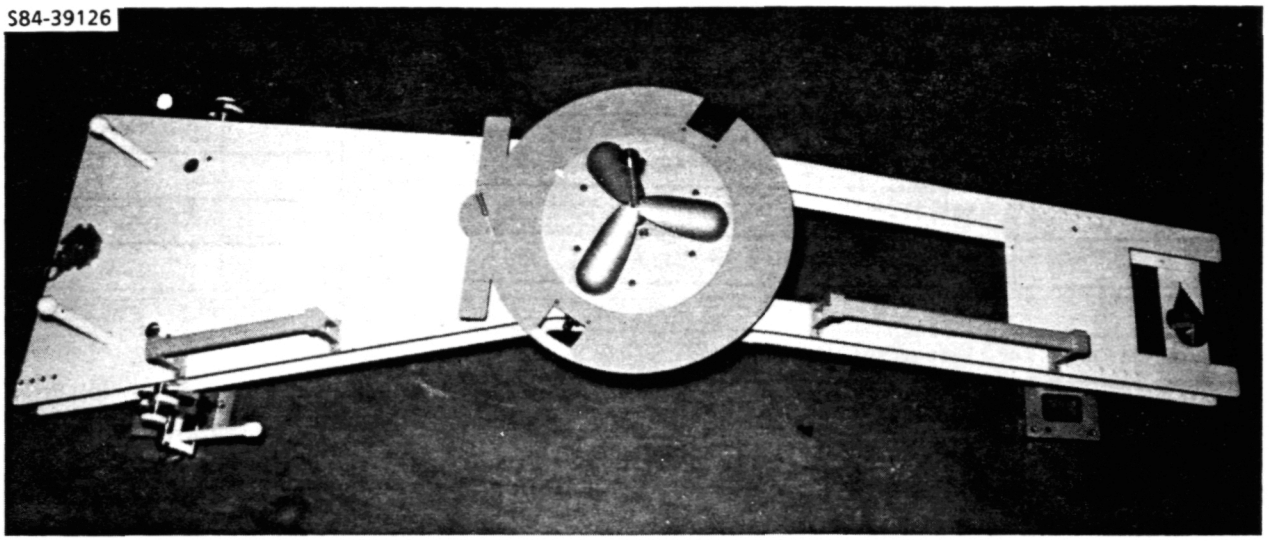
Dimensional Data	
A	14.25 in.
B	37.00 in.
C	7.00 in.



204660029.ART, 1

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

ANTENNA BRIDGE STRUCTURE



OVERVIEW

The antenna bridge structure (ABS) was designed to create a framework which distributes remote manipulator system (RMS)-induced forces on a Hughes satellite (HS376). The structure with brackets is 100 inches by 32 inches by 28 inches. The surface of the structure is coated with Chemglaze A276 white paint. It has an RMS grapple fixture and EVA handholds.

OPERATIONAL COMMENTS

The ABS was used on the HS376 retrieval mission. It was designed to be connected to a common bracket and a bumper bracket, which are attached to the satellite first. Velcro holds the ABS in position while connecting it to the brackets. After the ABS is secured, the RMS can maneuver the satellite. The ABS is a payload-unique device and is not normally manifested. It has mounting locations for the antenna cutter and a cut omnidirectional antenna.

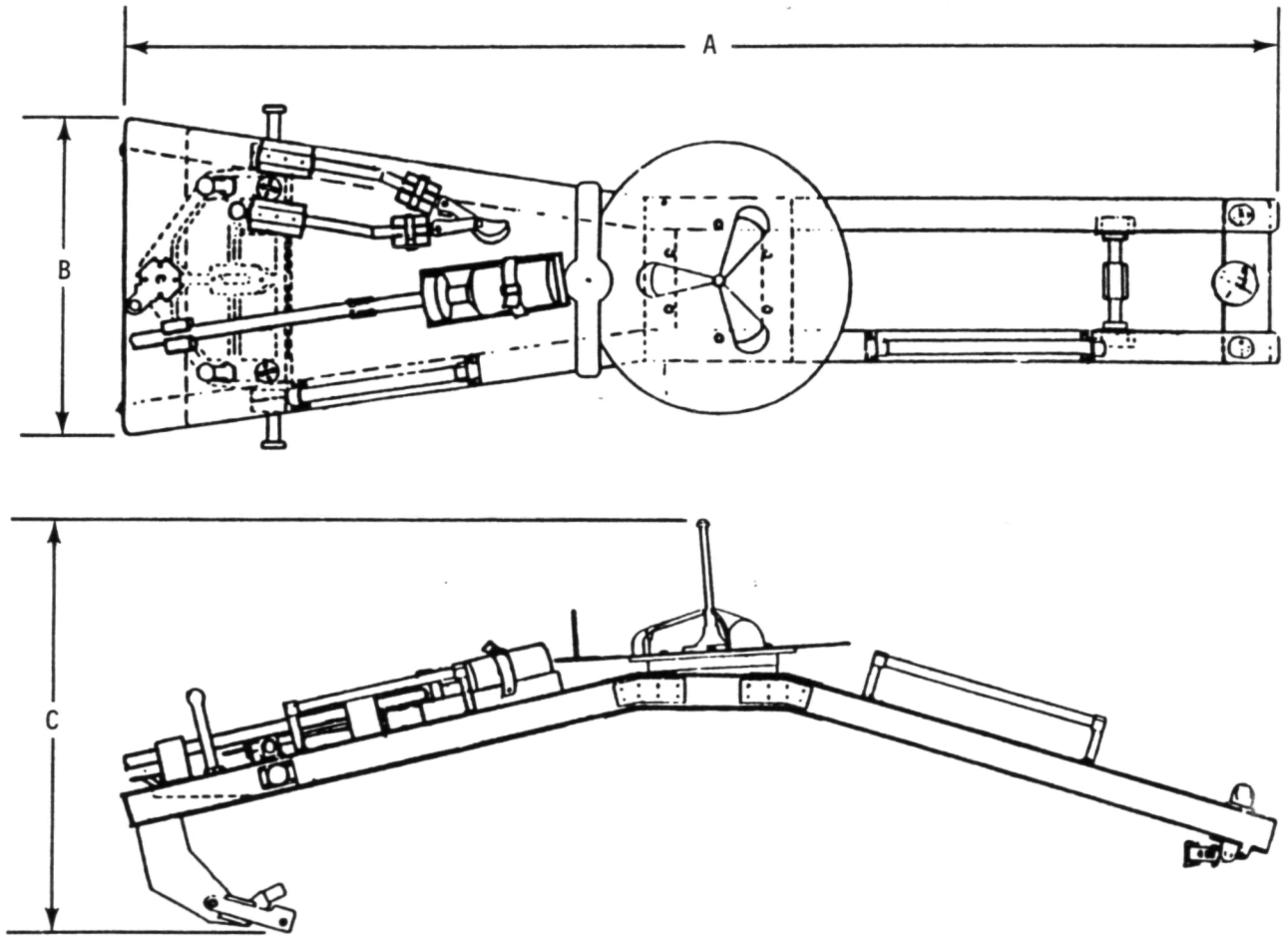
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: C. S. Allton, NASA/EC5, (713) 483-9152
Source: C. S. Allton, NASA/EC5, (713) 483-9152

ANTENNA BRIDGE STRUCTURE

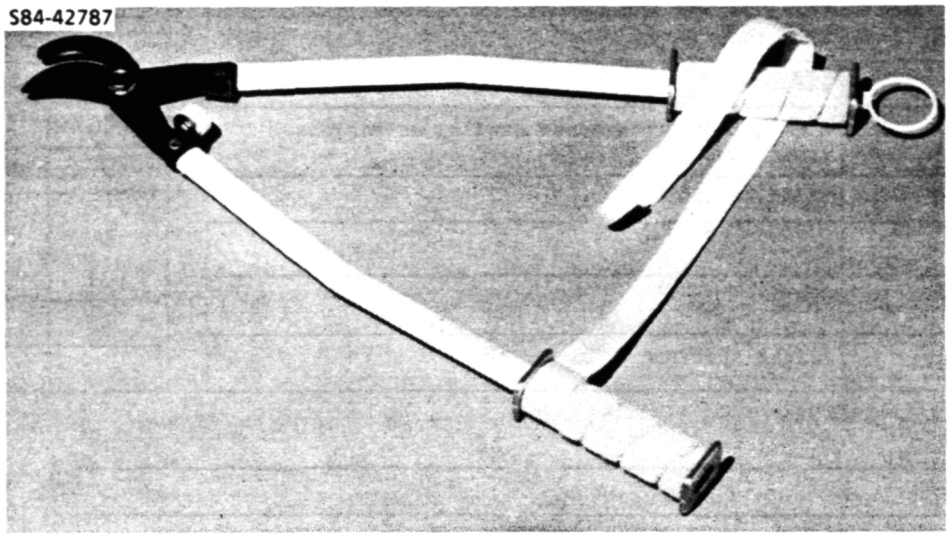
Technical Information	
Part number	SED39117098
Weight	116.5 lb
Material/ construction	Aluminum, Chemglaze A276 white paint, EVA handholds, RMS grapple fixture
Temperature range	-130° to 150° F
Availability	Flight specific

Dimensional Data	
A	97.0 in.
B	26.5 in.
C	36.0 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

ANTENNA CUTTER



OVERVIEW

The antenna cutter is a large cutter modified for EVA use. The cutter jaws are designed to cut objects up to 1-1/2 inches in diameter. A bumper keeps the handles 3 inches apart when the tool is closed; a Velcro strap keeps the handles closed. The cutter has black stainless steel jaws and aluminum handles, one handle equipped with a tether ring.

OPERATIONAL COMMENTS

The antenna cutter was used to cut carbon graphite tubing used as the mast of the omnidirectional antennas on the Hughes satellite 376 retrieval mission (Westar VI and Palapa B-2). The antenna cutter proved to be very effective in cutting the carbon graphite antenna mast because it generated no debris or carbon dust and made a clean cut. The Velcro strap must be loosened before the cutting jaws can be opened. The antenna cutter is not normally manifested.

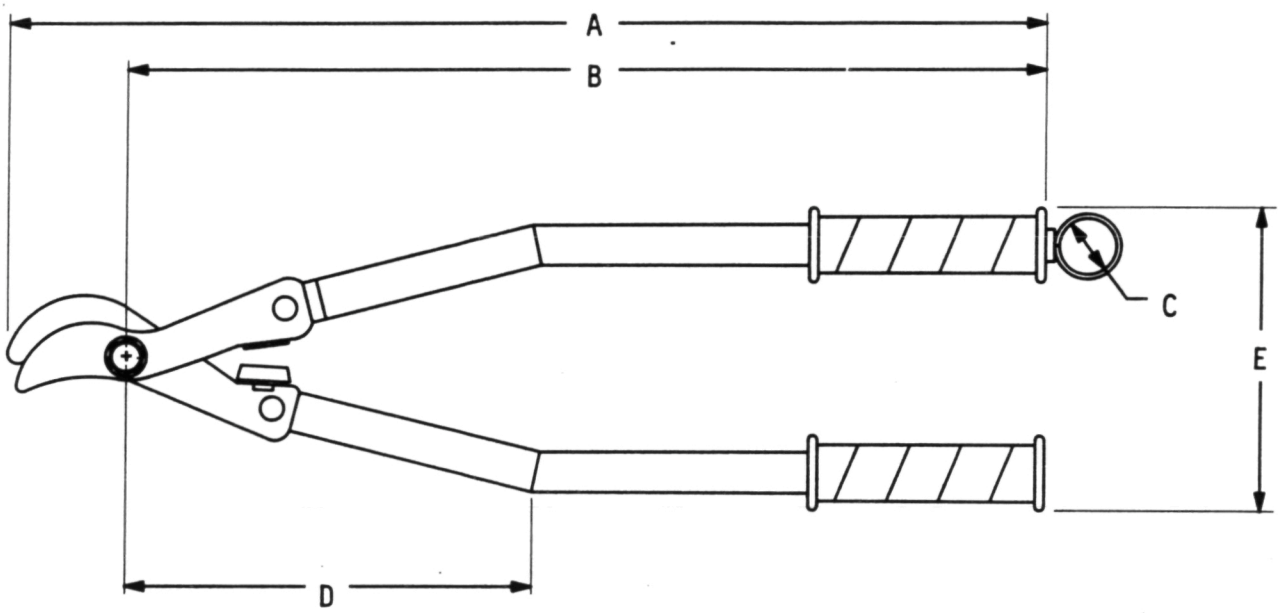
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: T. M. Grubbs, NASA/EC5, (713) 483-9149
Source: T. M. Grubbs, NASA/EC5, (713) 483-9149

ANTENNA CUTTER

Technical Information	
Part number	SED39117580-301
Weight	2.5 lb
Material	Aluminum Velcro-wrapped handles, stainless steel jaws
Temperature range	-130° to 150° F
Availability	Flight specific

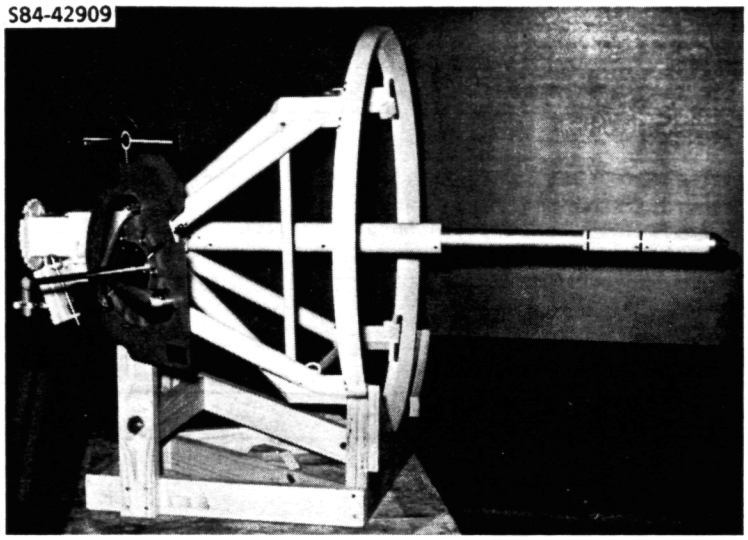
Dimensional Data	
A	22.00 in.
B	19.50 in.
C	1.20 in.
D	9.00 in.
E	6.12 in. (closed)



204660031.ART, 2

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

APOGEE KICK MOTOR CAPTURE DEVICE



OVERVIEW

The apogee kick motor capture device (ACD) is a mechanical interface between the manned maneuvering unit (MMU) and the apogee kick motor (AKM) of a Hughes HS376 satellite. The ACD includes a grapple fixture for use with the remote manipulator system (RMS). Two pip pins attach the ACD to the arms of the MMU. A toggle assembly with spring-loaded toggle fingers attaches the ACD to the satellite.

OPERATIONAL COMMENTS

The ACD must first be attached to the MMU before the MMU can position the ACD for capture of the satellite. The MMU is used to insert the toggle assembly at the tip of the ACD into the AKM of the satellite. Lines marked on the ACD indicate depth of insertion. Spring-loaded toggle fingers are then released inside the AKM to secure the satellite.

The RMS attaches to the grapple fixture on the ACD and holds the satellite while an antenna bridge structure (ABS) is attached to it. The ACD and MMU are then used to hold the satellite while the RMS moves to the grapple fixture of the ABS. The ACD is then released from the satellite and restowed, using the MMU.

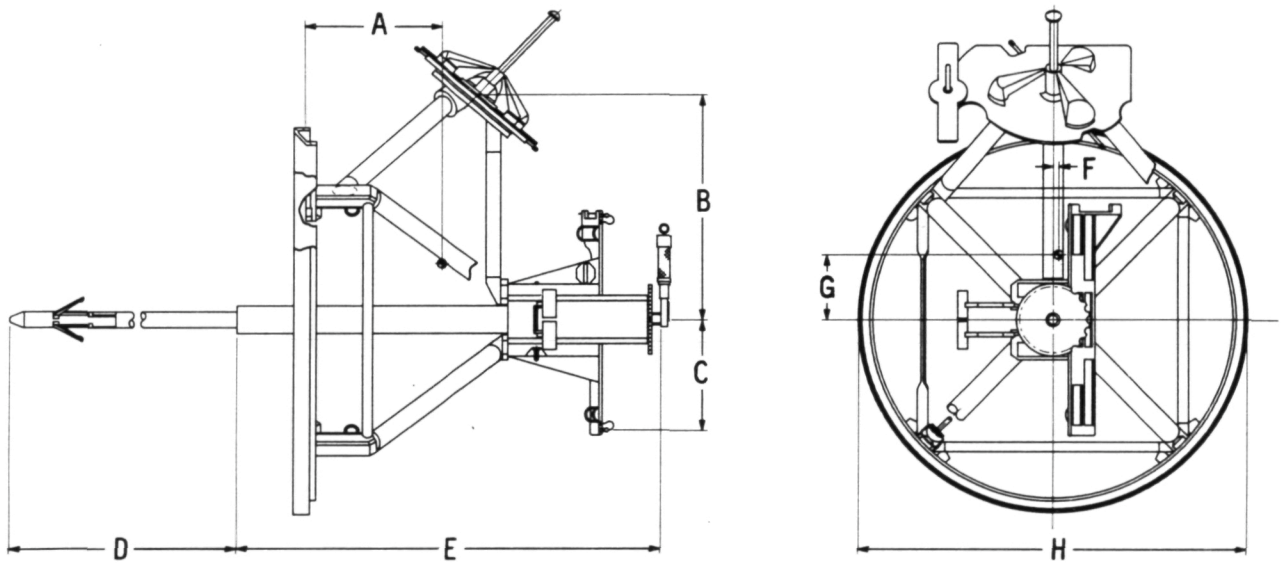
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: W. D. Harwell, NASA/EC5, (713) 483-9155
Source: C. E. Whitsett, NASA/EC1, (713) 483-9111

APOGEE KICK MOTOR CAPTURE DEVICE

Technical Information	
Part number	SED39117132
Weight	128 lb
Material	Stainless steel, aluminum alloy
Major components	Toggle assembly, control box and retractor, separation ring struts and structure, RMS grapple fixture (trunnion pin attachment device unit)
Design temperature range	-130° to 150° F
Quantity flown	Two for STS 51-A
Stowage	Spacelab pallet
Availability	Flight specific

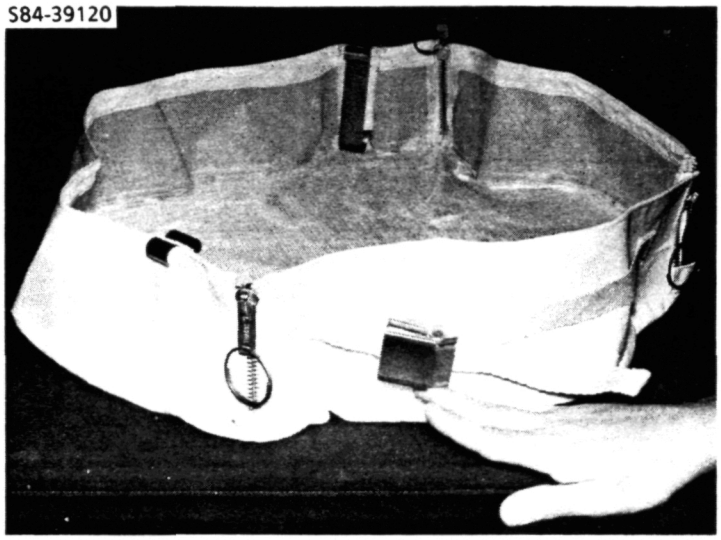
Dimensional Data	
A	14.28 in.
B	23.89 in.
C	11.50 in.
D	27.00 in.
E	44.18 in.
F	0.50 in.
G	6.00 in.
H	41.04 in.



204660032.ART, 2

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

APOGEE KICK MOTOR NOZZLE COVER



OVERVIEW

The apogee kick motor (AKM) nozzle cover assembly is a fabric cover which fits over Palapa/Westar type satellite nozzles to prevent contamination of the payload bay area by burned residue lining the nozzle interior.

OPERATIONAL COMMENTS

The AKM nozzle cover is constructed of Ortho fabric with Armalon reinforcement along the sides. The cover is installed onto the nozzle by EVA crewmembers prior to soft docking the satellite into the payload bay. Installation is facilitated by zippers at three side positions. Two nozzle clips and a pull strap assure a secure fit of the cover over the nozzle. Two of these covers were successfully used on STS 51-A.

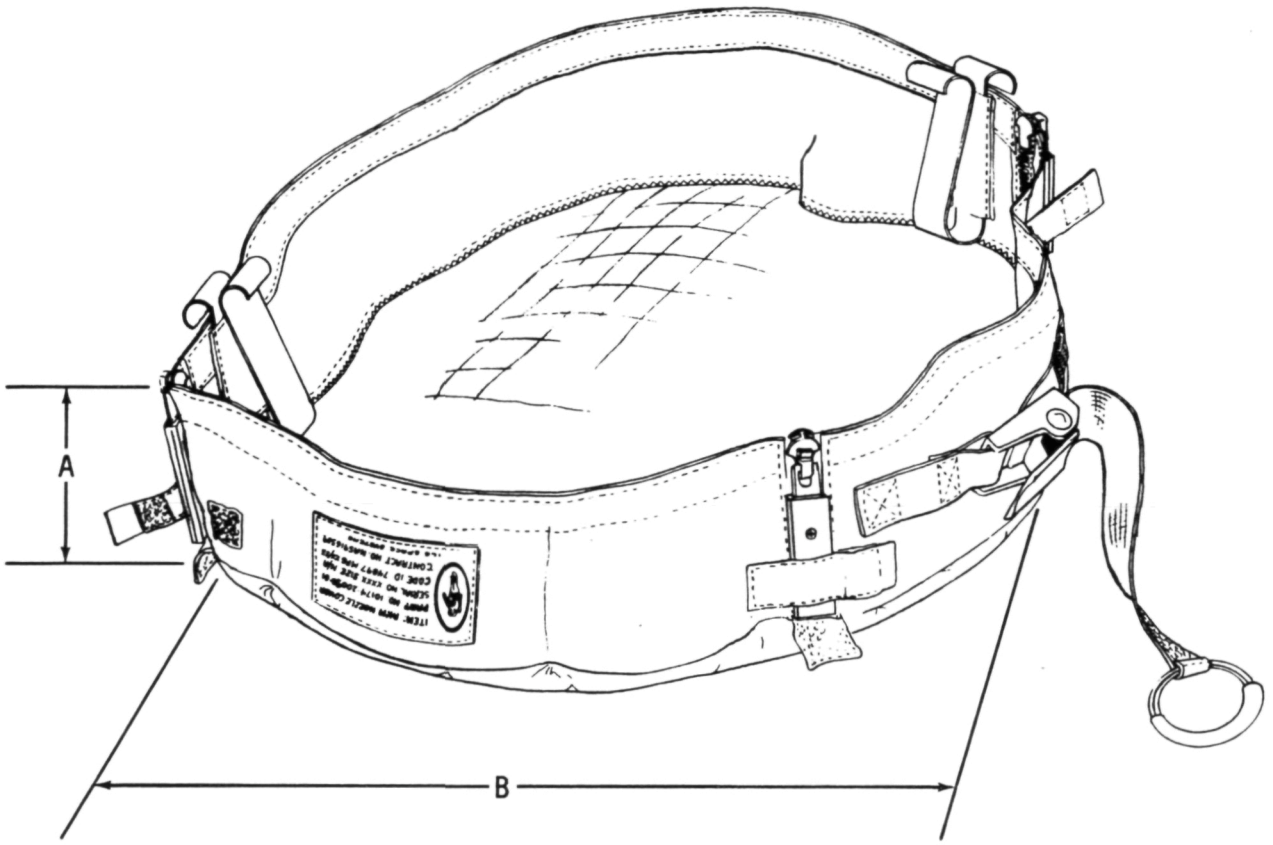
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

APOGEE KICK MOTOR NOZZLE COVER

Technical Information	
Part number	10174-20090-01
Weight	2.2 lb
Material	Ortho and Armalon fabrics
Stowage	Spacelab pallet tool stowage bag on tool board #2
Availability	Flight specific

Dimensional Data	
A	4.5 in.
B	25.5 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

BAG, EVA

OVERVIEW

The EVA bag is used to stow various items in the airlock for possible use during EVA. It is fabricated from Nomex material and has snap and Velcro attachment points. A 27-1/2-inch Velcro strap is coiled up at each top corner of the bag.

OPERATIONAL COMMENTS

The EVA bag contains items on both sides of the main fabric base. Pockets on one side provide stowage for a camera, thermal mittens, a tool caddy, a display and control module (DCM) plug, and a set of contingency hatch tools. The reverse side has only one pocket, which holds EVA cue cards. The crewmembers can use the Velcro straps to tether the bag where necessary. This bag is installed inside the airlock over the outer hatch during the EVA preparation period. It is fixed to the airlock wall by four push-on snaps.

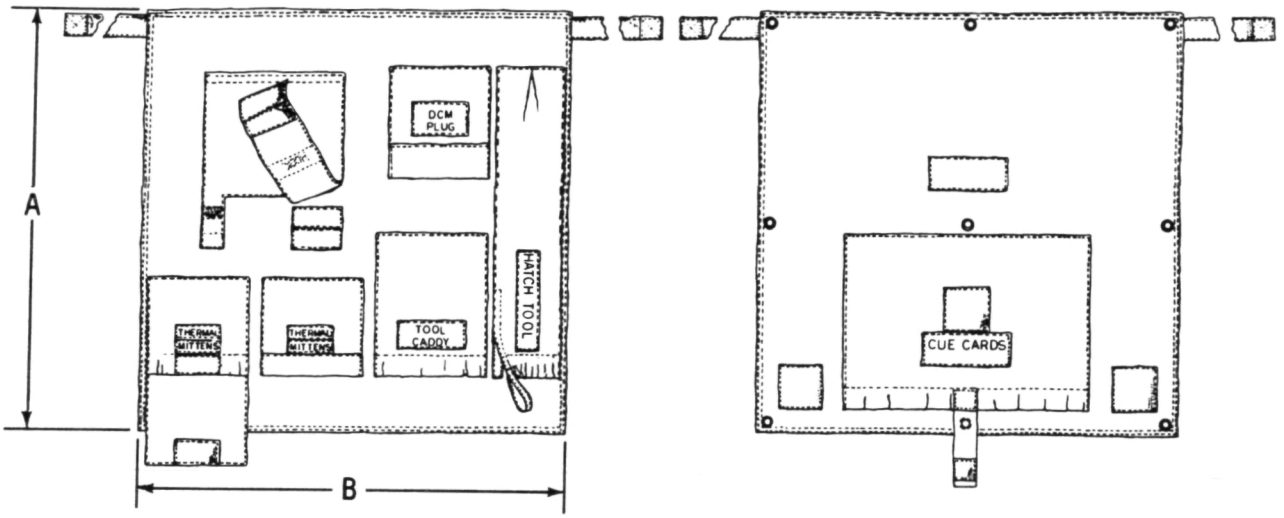
CONTACTS

Operational: C. H. Armstrong, NASA/DF42, (713) 483-2588
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

BAG, EVA

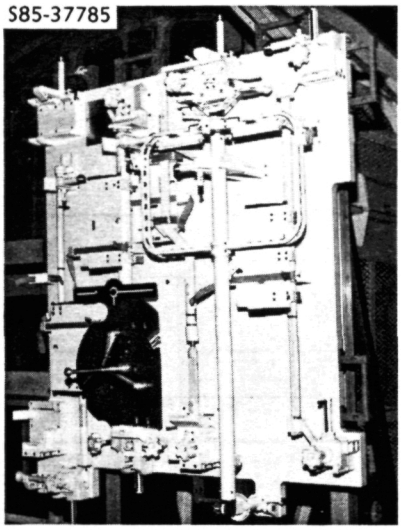
Technical Information	
Part number	10108-10081-01
Weight	0.72 lb
Material	Nomex
Quantity flown	One
Stowage	Volume H locker
Availability	Standard

Dimensional Data	
A	19.5 in.
B	19.5 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

BAR STOWAGE ASSEMBLY



OVERVIEW

The bar stowage assembly (BSA) was designed as an EVA equipment carrier for the Leasat Salvage Mission. The BSA consists of a mounting plate and attachment devices to secure equipment during launch and landing.

OPERATIONAL COMMENTS

The BSA allows for equipment attachment via a receiver at one end and a spring-loaded latch at the opposite end. Fasteners and center holddowns for tool boards are also a part of the design. The BSA was mounted on a starboard sill longeron get-away special (GAS) beam for STS 51-I. The capture bar, grapple bar, handling bar, spin-up bar, and work station stanchion were stowed on the BSA.

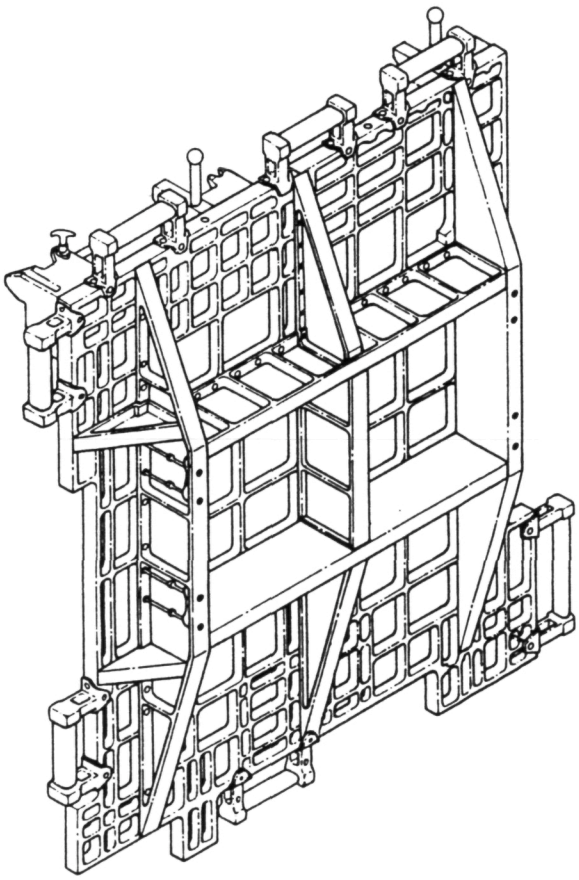
CONTACTS

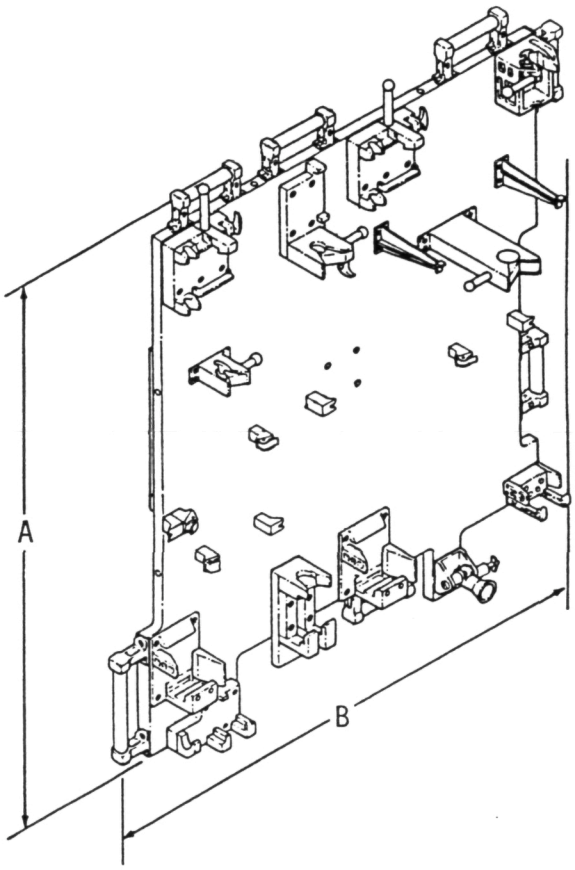
Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

BAR STOWAGE ASSEMBLY

Technical Information	
Part number	10176-20002-01
Weight	266.0 lb (without bars) 415.0 lb (with bars/tool boards) 597.0 lb (with bars/tool boards/GAS beam)
Material/ construction	Aluminum
Temperature range	-130° to +150° F
Availability	Flight specific

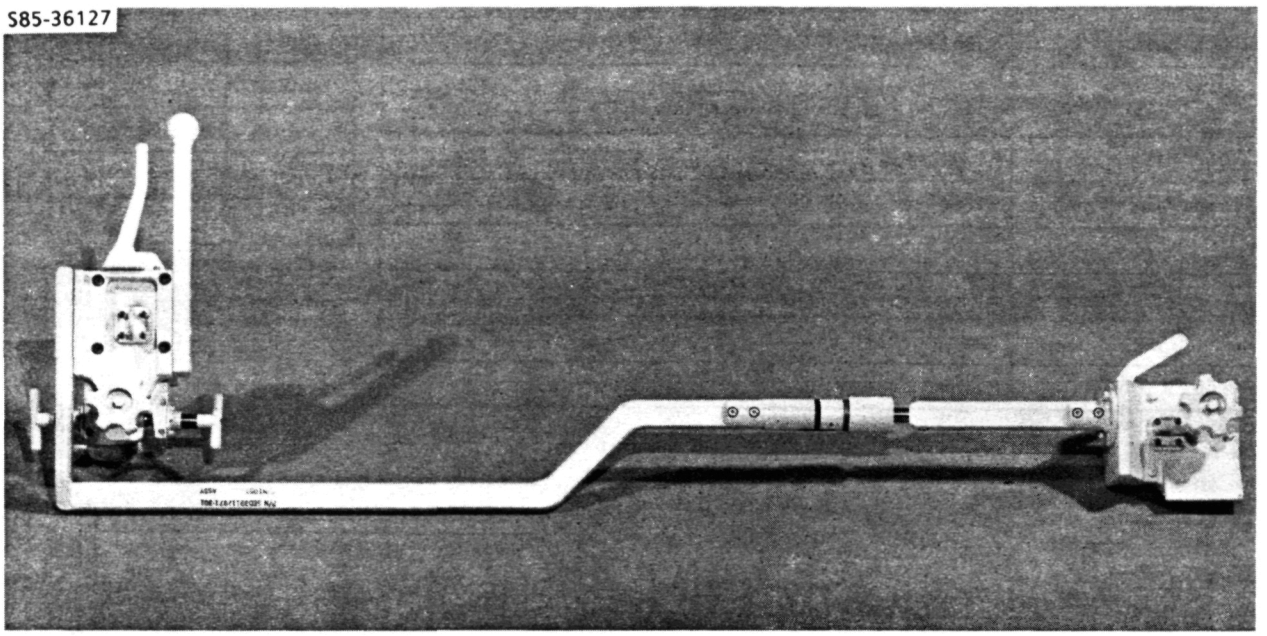
Dimensional Data	
A	68.88 in.
B	66.45 in.





ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

BAR, CAPTURE



OVERVIEW

The capture bar was designed for use during the Leasat salvage mission.

OPERATIONAL COMMENTS

The capture bar interfaces with the Leasat forward and aft pushoff side fittings and provides the crewmember with a means of capturing and despinning the satellite. Two capture bars, one prime and one spare, were flown on STS 51-I. Both were stowed on the bar stowage assembly.

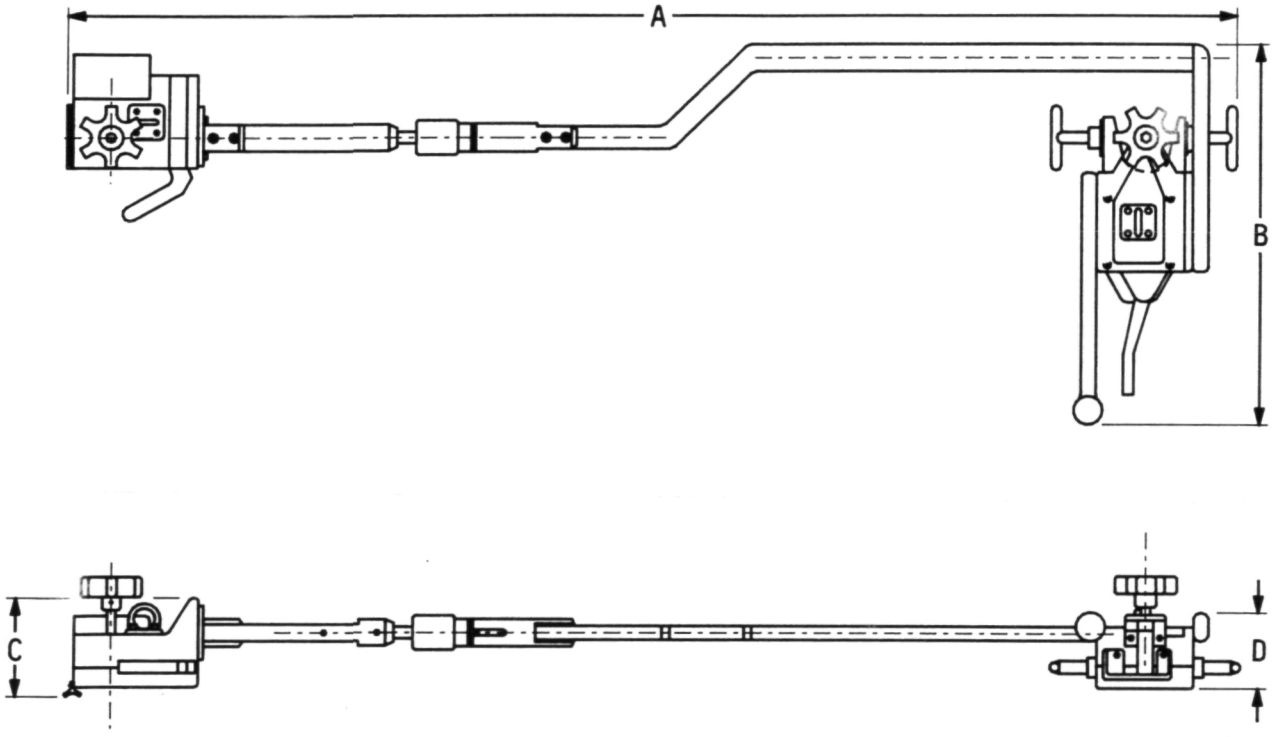
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: C. S. Allton, NASA/EC511, (713) 483-9152

BAR, CAPTURE

Technical Information	
Part number	SED 39117971-301
Weight	23.5 lb (without tool board) 28.0 lb (with tool board)
Material	Aluminum
Temperature range	-130° to +150° F
Availability	Flight specific

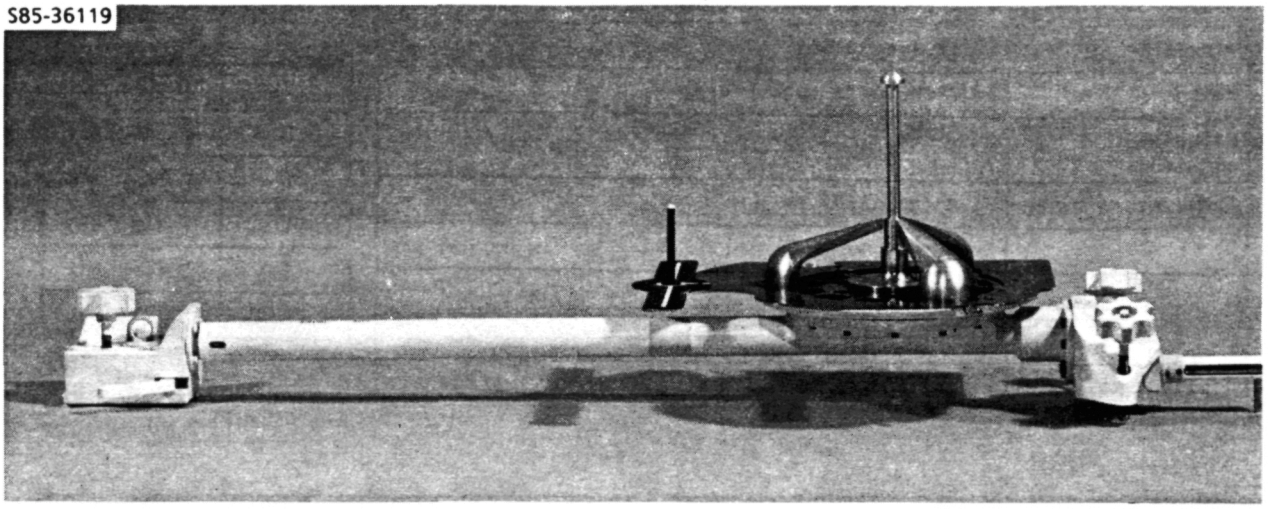
Dimensional Data	
A	57.873 in.
B	18.938 in.
C	4.656 in.
D	3.750 in.



204660176.ORT,5

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

BAR, GRAPPLE



OVERVIEW

The grapple bar was designed for use during the Leasat salvage mission.

OPERATIONAL COMMENTS

The grapple bar was installed on the Leasat forward and aft pushoff side fittings after the capture bar was removed. The grapple bar has a flight standard grapple fixture mounted on it that permitted the remote manipulator system (RMS) to grapple the Leasat. 7/16-inch hex bolts can be used for EVA release of the grapple fixture pin should the RMS end effector fail. One grapple bar was flown on STS 51-I. It was stowed on toolboard no. 3 of the bar stowage assembly (BSA).

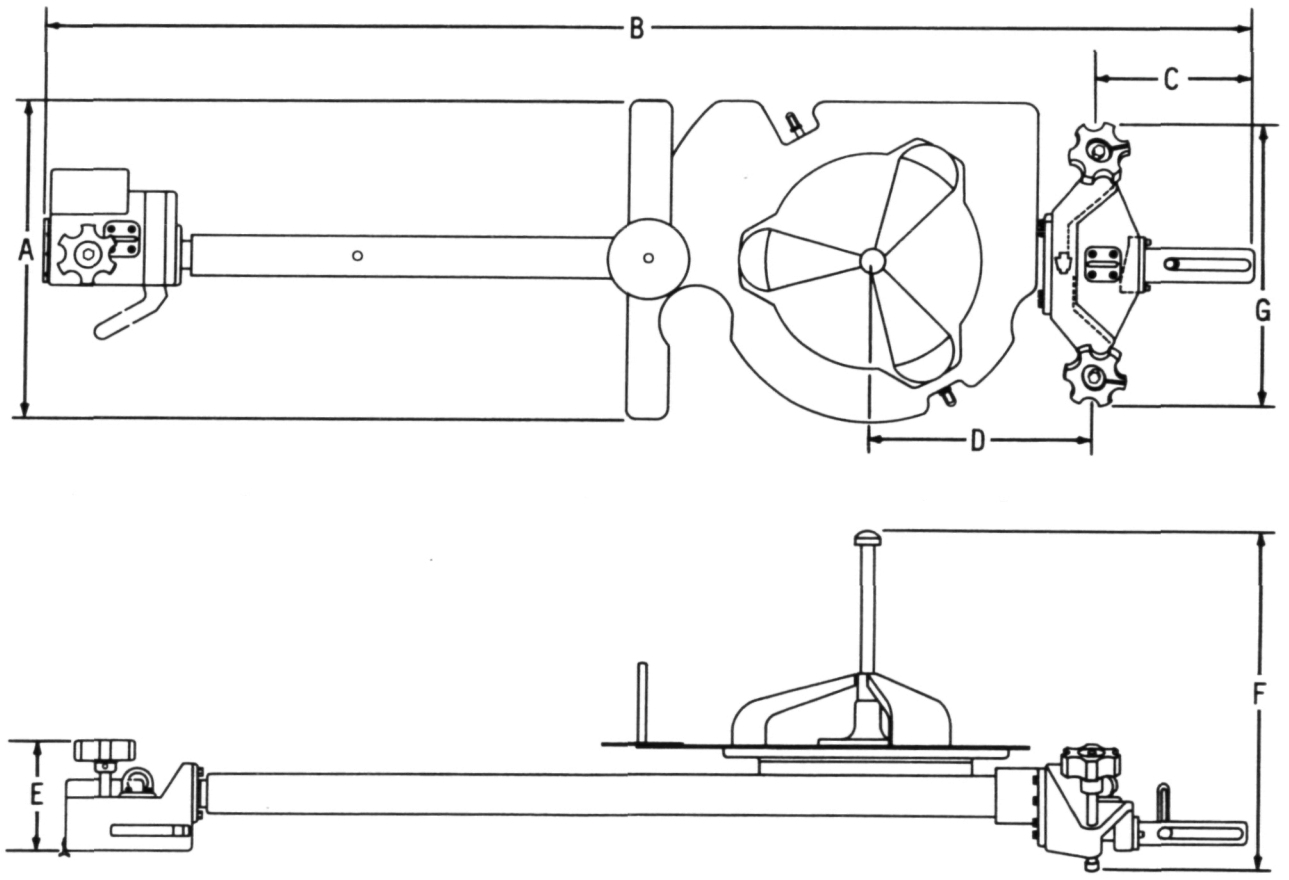
CONTACTS

Operational: R. C. Trevino, NASA/DF2, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: C. S. Allton, NASA/EC511, (713) 483-9152

BAR, GRAPPLE

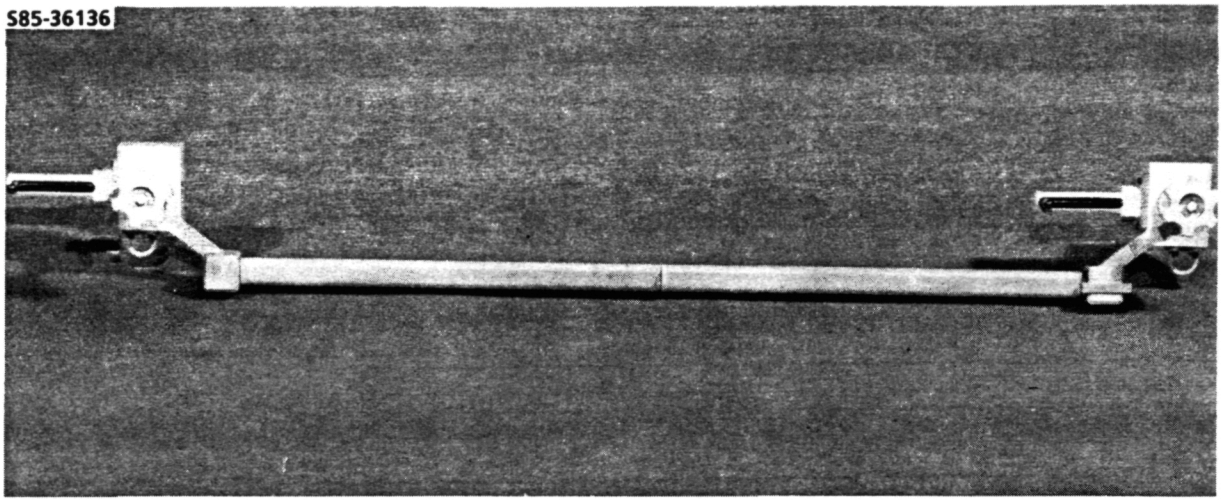
Technical Information	
Part number	SED 39118030-301
Weight	56.6 lb (with tool board)
Material/ construction	Aluminum
Temperature range	-130° to +150° F
Availability	Flight specific

Dimensional Data	
A	16.000 in.
B	60.840 in.
C	7.550 in.
D	11.000 in.
E	5.812 in.
F	17.425 in.
G	14.000 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

BAR, HANDLING



OVERVIEW

The handling bar was designed for use during the Leasat Salvage Mission.

OPERATIONAL COMMENTS

The handling bar was designed to interface with the Leasat forward and aft pushoff side fittings. It was used to provide the crewmember with a means of handling and restraining the satellite while the capture bar was being removed and the grapple bar was being installed. It was stowed on toolboard no. 4 of the bar stowage assembly (BSA).

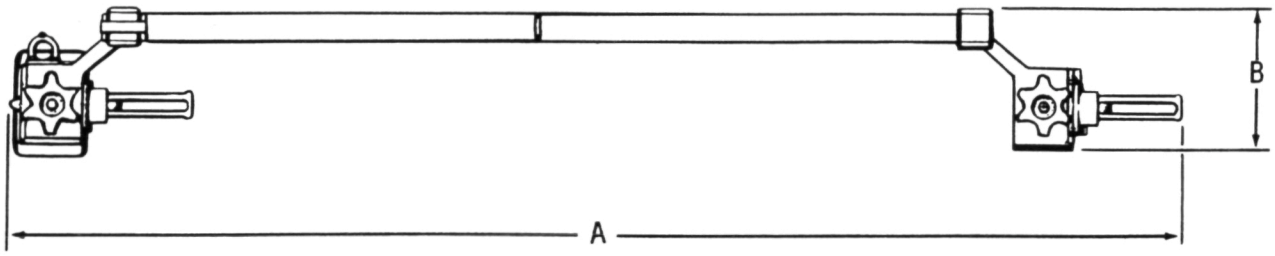
CONTACTS

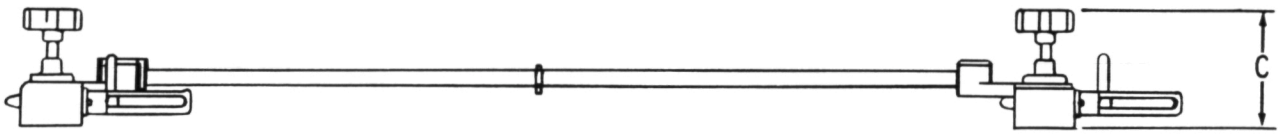
Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: W. D. Harwell, NASA,/EC2, (713) 483-9155

BAR, HANDLING

Technical Information	
Part number	SED 3911800-301
Weight	15.5 lb (with tool board)
Material/ construction	Aluminum
Temperature range	-130° to +150° F
Availability	Flight specific

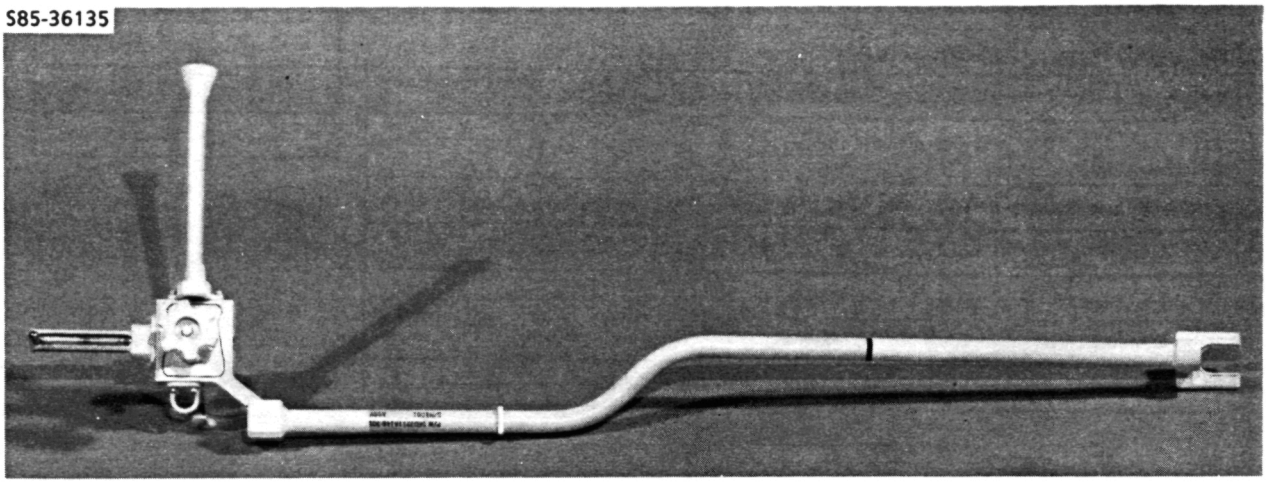
Dimensional Data	
A	60.73 in.
B	6.99 in.
C	5.87 in.





ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

BAR, SPIN-UP



OVERVIEW

The spin-up bar was designed for use during the Leasat Salvage Mission.

OPERATIONAL COMMENTS

The spin-up bar was designed to be installed on the Leasat forward and aft pushoff side fittings. The bar was installed after the grapple bar was removed. It provided the crewmember with a means of spinning up and deploying the satellite. The spin-up bar remains on the Leasat in orbit. It was stowed on toolboard no. 5 of the bar stowage assembly (BSA) for the launch of STS 51-I.

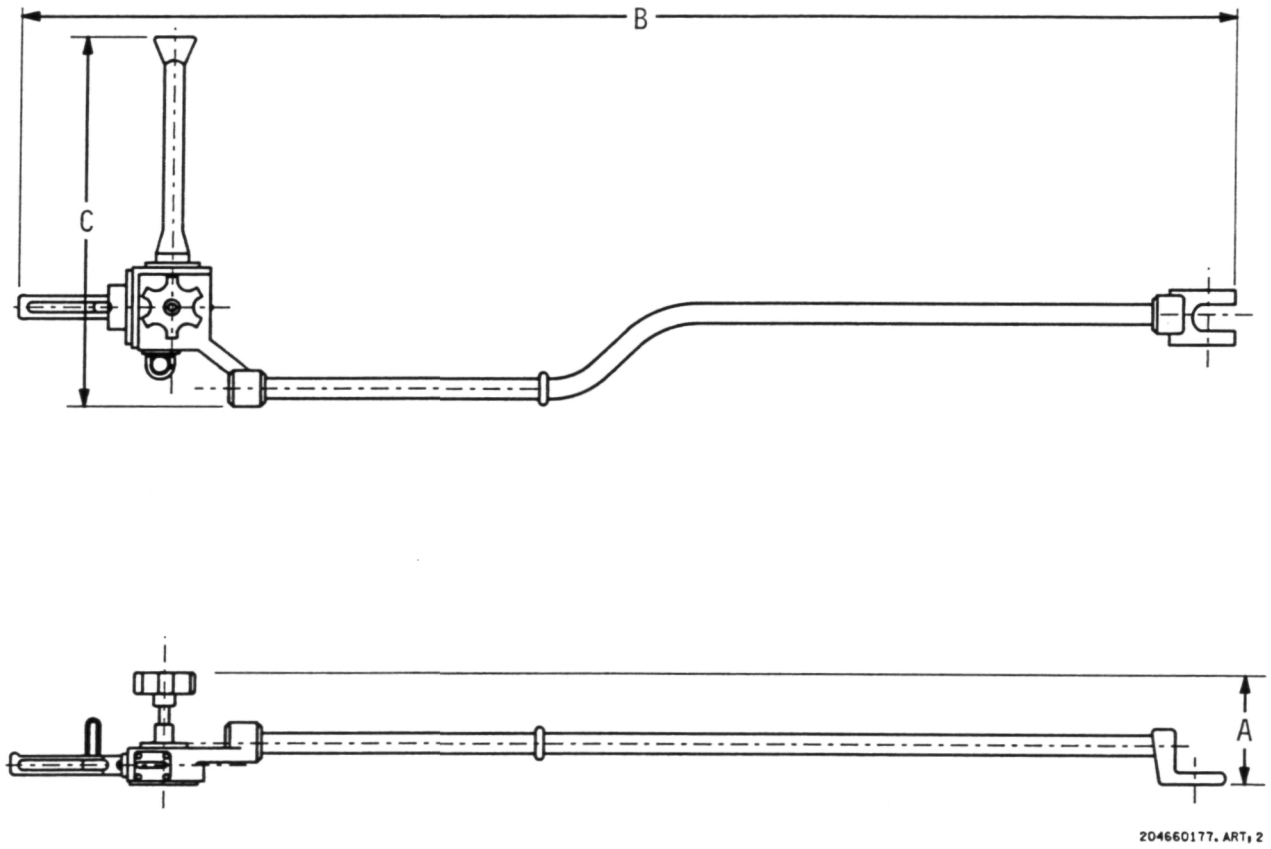
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: L. Willis, NASA/EC511, (713) 483-9153

BAR, SPIN-UP

Technical Information	
Part number	SED 39118146-301
Weight	8.0 lb (with tool board)
Material/ construction	Aluminum
Temperature range	-130° to +150° F
Availability	Flight specific

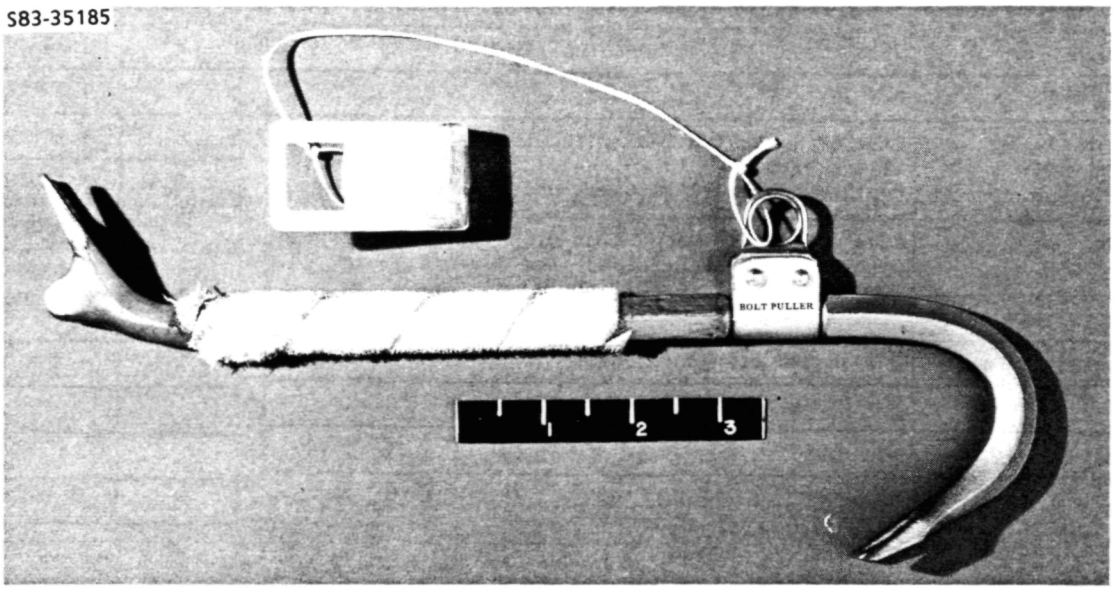
Dimensional Data	
A	5.60 in.
B	60.42 in.
C	15.60 in.



204660177.ART, 2

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

BOLT PULLER



OVERVIEW

The bolt puller is a common crowbar modified for EVA use and for improved leverage in confined spaces. A tool ring for tethering has been added near the claw end, and the tool is partially wrapped in Velcro. Both ends of the tool are tapered and slotted. The end opposite the claw end has a 1/2-inch cylindrical piece attached near the end to provide a heel for leverage for prying with that end. That same end has a protective cover which is attached to the tether ring by a string.

OPERATIONAL COMMENTS

The bolt puller is one of the jam removal tools. Its primary use is for prying or unjamming. It can be used to remove a bolt after the nut has already been removed. One end has been sized specifically to fit the bolts at the three disconnect points at each door drive bellcrank.

This tool is part of the normally manifested STS equipment. It is wrapped in a Velcro-lined tool caddy along with the vise-grip pliers and stowed in the starboard provisions stowage assembly (PSA).

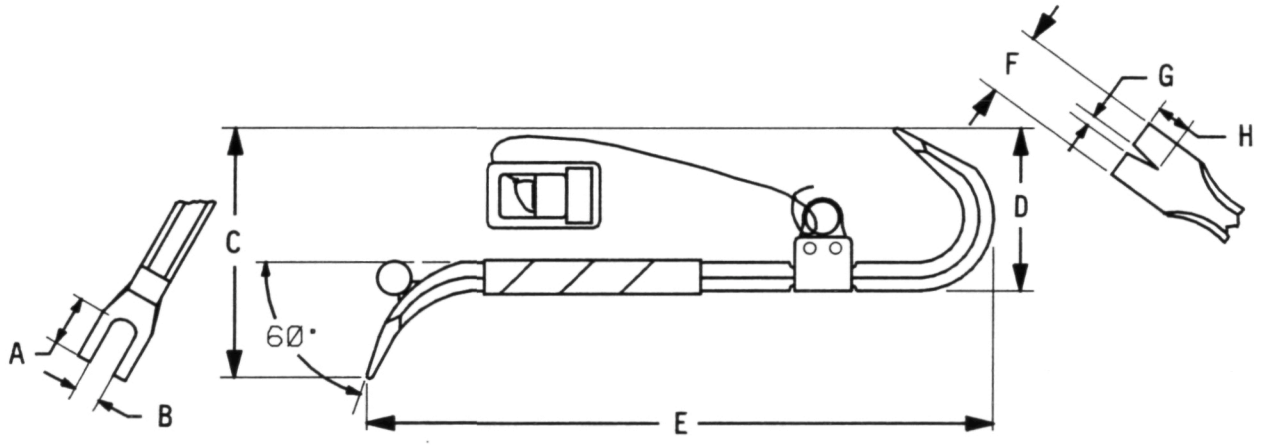
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: J. Madden, Rockwell/Houston, (713) 282-5300

BOLT PULLER

Technical Information	
Part number	V628-650880-009 or SDD33103435-301
Weight	0.8 lb
Material/ construction	Crowbar - Stanley tool #112, tool steel Heat treatment - to Rockwell C20 to C30 hardness Plating - commercial electroless nickel plating
Tips	Claw end has V-shaped slot 0.56 in. long Opposite end has U-shaped slot 0.64 in. long
Temperature range	-200° to 250° F (operational)
Quantity flown	One in the starboard PSA
Availability	Standard

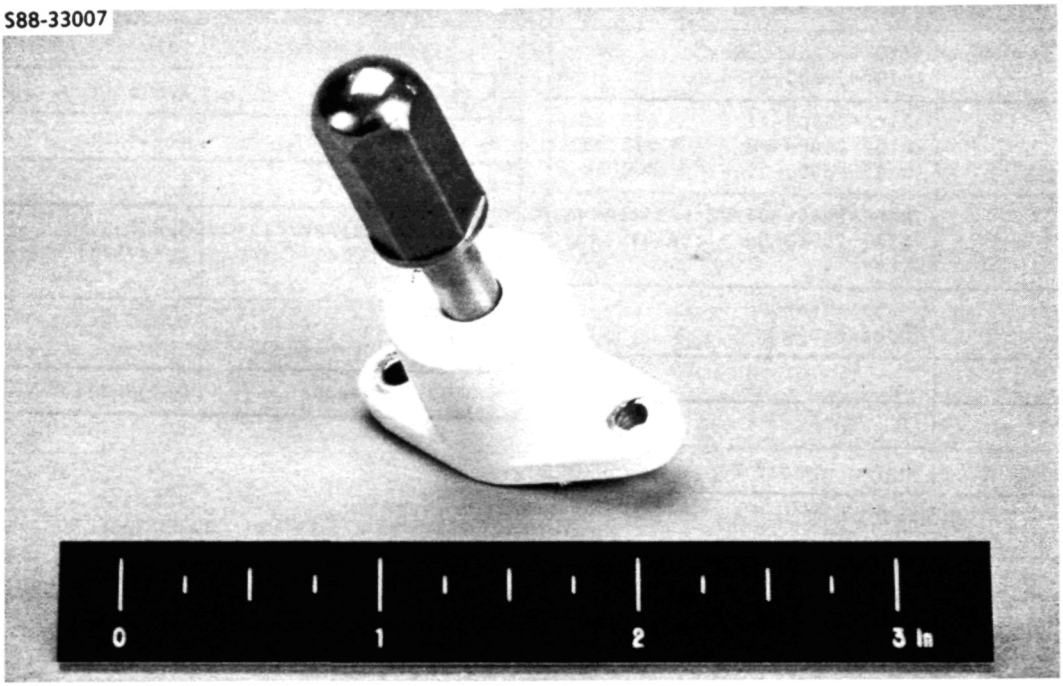
Dimensional Data	
A	0.640 in.
B	0.375 in.
C	4.100 in.
D	2.900 in.
E	10.000 in.
F	1.060 in.
G	0.250 in.
H	0.560 in.



204660035.ART:4

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

BOLT, EVA HEX-HEAD



OVERVIEW

EVA hex-head bolts, commonly known as double-height bolts, are used in a variety of EVA applications. They are recommended for use as a standard bolt interface on any EVA equipment.

OPERATIONAL COMMENTS

EVA hex-head bolts are used on the trunnion pin attachment device, the remote manipulator system (RMS) portable foot restraint attachment device, the RMS flight releasable grapple fixture, and the Hubble Space Telescope (HST). The bolts are fabricated to meet the requirements of the item on which they are to be used. In general, the height of the bolt is double the distance across the flats. The shaft length is design-dependent.

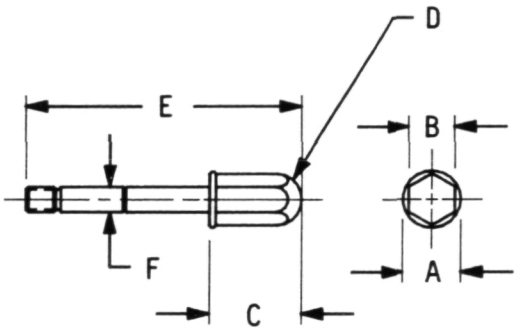
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 480-9080

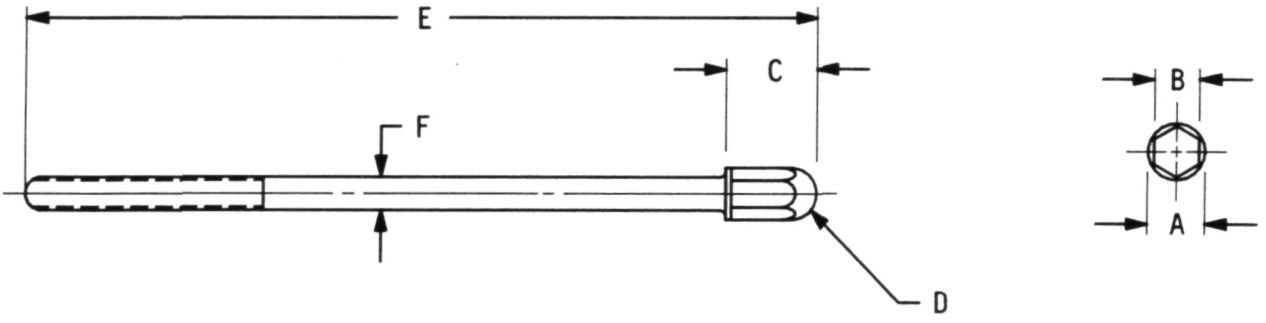
BOLT, EVA HEX-HEAD

Technical Information	
Part number	10169-20405-01/02 10187-20023-01
Weight	10169-20405-01 0.529 lb 10169-20405-02 0.575 lb 10187-20023-01 0.069 lb
Material/ construction	10169-20405-01/02 - titanium 10187-20023-01 - stainless steel
Temperature range	-150° to +250° F (operational)
Availability	Flight specific

Dimensional Data		
	10169-20405-01/02	10187-20023-01
A	0.500 in.	0.560 in.
B	0.431 in.	0.437 in.
C	0.880 in.	0.880 in.
D	0.250 spherical radius	0.250 spherical radius
E	7.130 (-01) in. 7.630 (-02) in.	2.630 in.
F	0.312 in.	0.250 in.



10187-20023

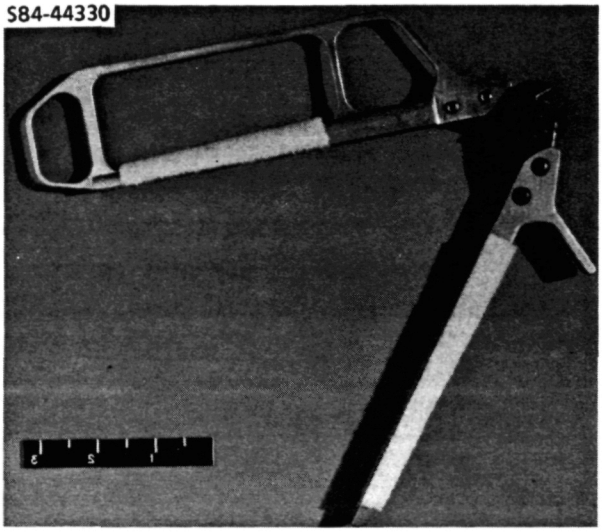


10169-20405

204660444.ORT, 2

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

CABLE CUTTER



OVERVIEW

The cable cutter is a standard cutter modified for EVA use. It is equipped with large handles to fit the EVA glove. The tool handles are covered with Velcro with a tether point provided. The cutter jaw opening measures 5/16 inch wide and 5/16 inch deep when fully open.

OPERATIONAL COMMENTS

The cable cutter is operated with two hands and closed to capture the cable in the cutting jaws. At the capture position, the handles may then be operated with one hand to cut the cable. The cable cutters are part of the normally manifested STS equipment. They are wrapped in a Velcro-lined tool caddy along with the 1/2-inch ratcheting box end wrench.

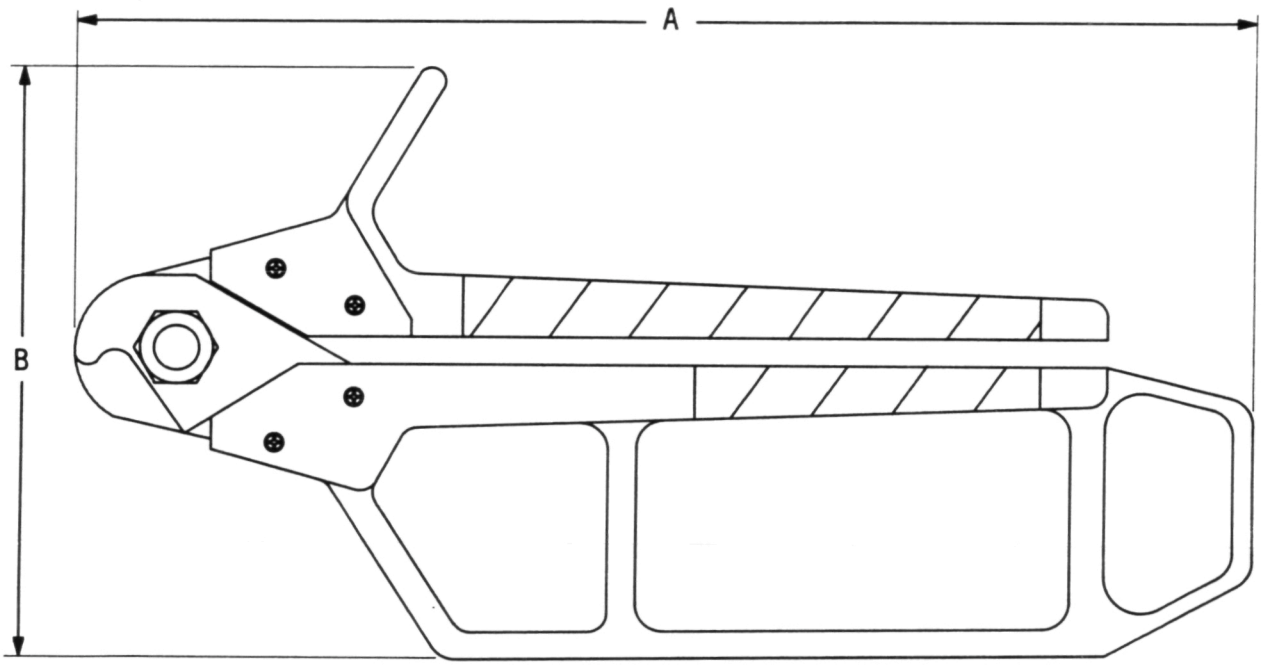
CONTACTS

Operational: R. C. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: M. Withey, ILC Space Systems, (713) 488-9080

CABLE CUTTER

Technical Information	
Part number	SED39117075-301
Weight	0.34 lb
Material/ construction	7075 aluminum handles, stainless steel jaws, Velcro-wrapped handles, tether attachment
Temperature range	-200° to 250° F (operational)
Availability	Standard.

Dimensional Data	
A	8.25 in.
B	4.25 in.

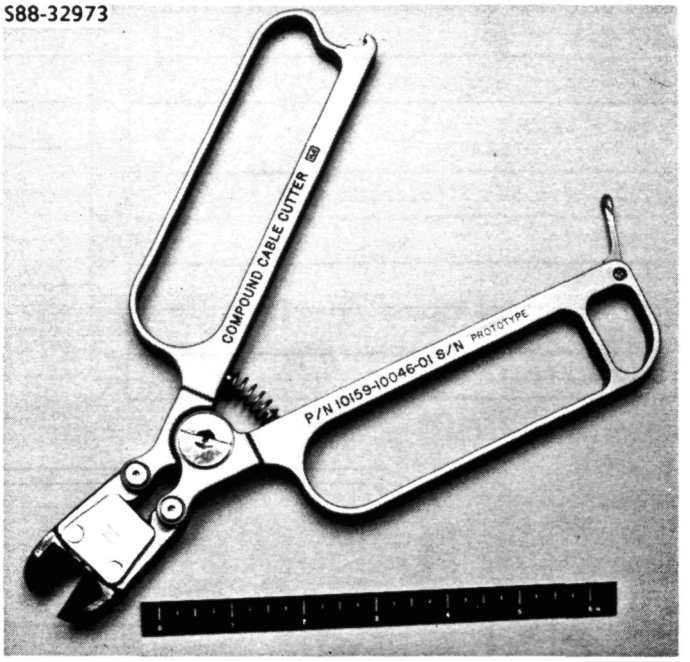


204660036.ART, 4

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

CABLE CUTTER, COMPOUND

S88-32973



OVERVIEW

The compound cable cutter is designed to cut small cables and wire harnesses. It is currently in development. It will cut cables and harnesses up to 0.19 inch in diameter.

OPERATIONAL COMMENTS

The compound cable cutter is equipped with large handles to fit the EVA gloved hand and is designed for one-handed operation. The cutter jaw opening measures 9/16 inch wide and 7/8 inch deep when fully opened.

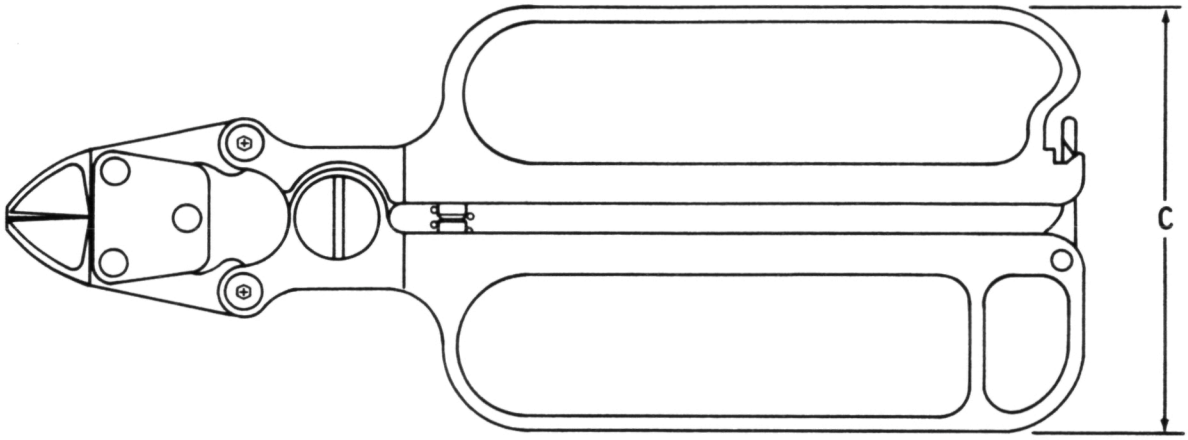
CONTACTS:

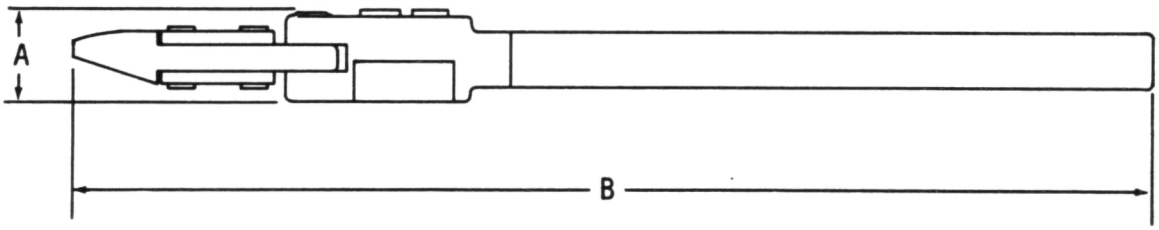
Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: M. Withey, ILC Space Systems, (713) 488-9080

CABLE CUTTER, COMPOUND

Technical Information	
Part number	10159-10046-01
Weight	0.728 lb
Material/ construction	Jaws - Carbon steel Handles - Aluminum
Temperature range	-200° to +250° F (operational)
Maximum diameter cut	0.19 in.
Availability	Developmental

Dimensional Data	
A	0.80 in.
B	9.40 in.
C	3.75 in.

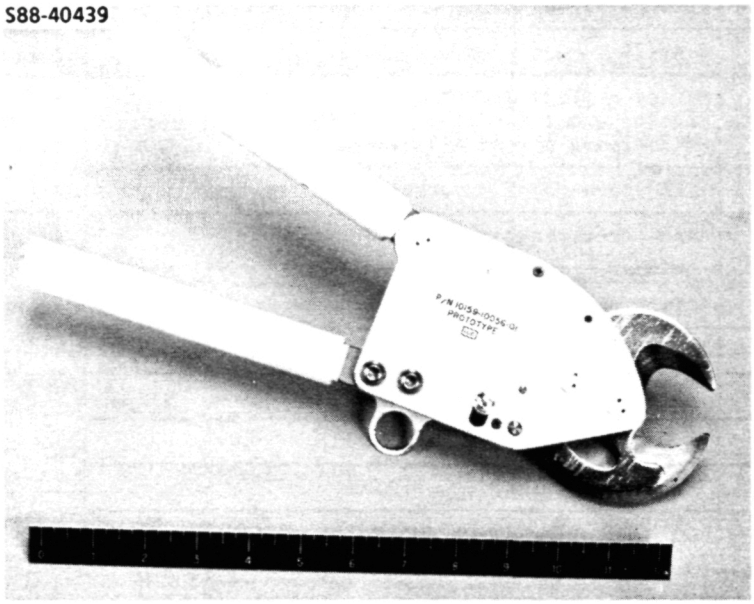




ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

CABLE CUTTER, LARGE

S88-40439



OVERVIEW

The large cable cutter, also known as the EVA cable cutter, is a contingency tool designed to cut the interface wiring bundles of a payload which requires jettisoning. The cutter is designed to cut unpowered copper electrical cables up to 1 inch in diameter, including the insulation. The maximum cross sectional area of the copper that can be cut is 350,000 circular miles (0.275 square inches). The cutter is not designed to cut steel cables. Shrouds cover the moving parts within the cutter housing to avoid pinching gloved fingers. Low profile shoulder screws are employed to avoid snagging tethers. A tether ring is supplied to transfer the tool to and from the worksite. The cutter is stowed in the port provisions stowage assembly (PSA).

OPERATIONAL COMMENTS

The blades are indexed by a ratcheting mechanism inside the cutter to assist in creating the force required to cut the wiring bundles. A spring-loaded, quick-return feature returns the blades for the next cutting task.

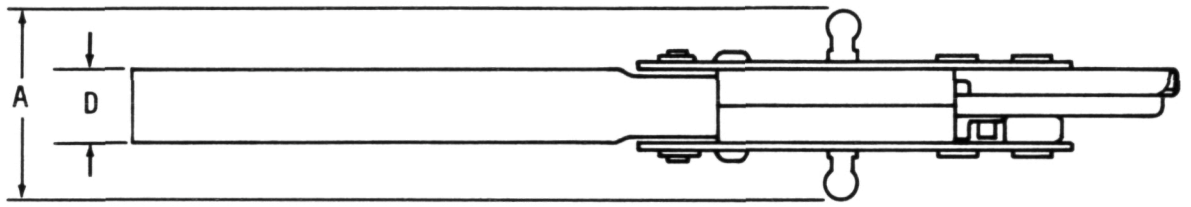
CONTACTS

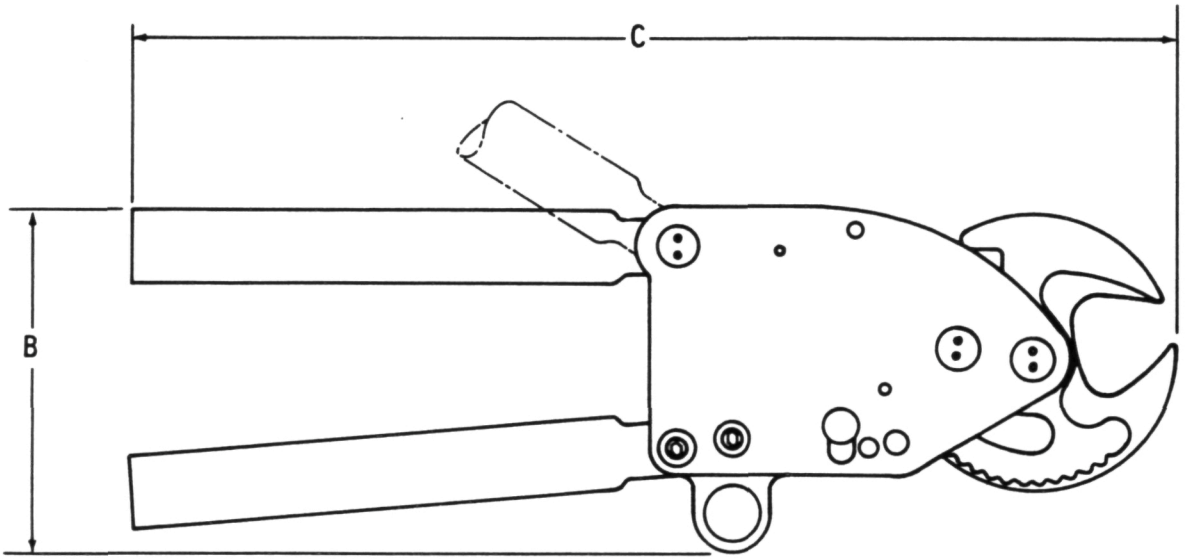
Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

CABLE CUTTER, LARGE

Technical Information	
Part number	10159-10056-02
Weight	3.47 lb
Material/ construction	Blades - Stainless steel Housing and internal parts - Stainless steel Handles and shroud - Aluminum
Temperature range	-200° to +250° F (operational)
Designed to cut maximum diameter of	1-in. copper cable
Stowage	Port PSA
Quantity flown	One
Availability	Standard

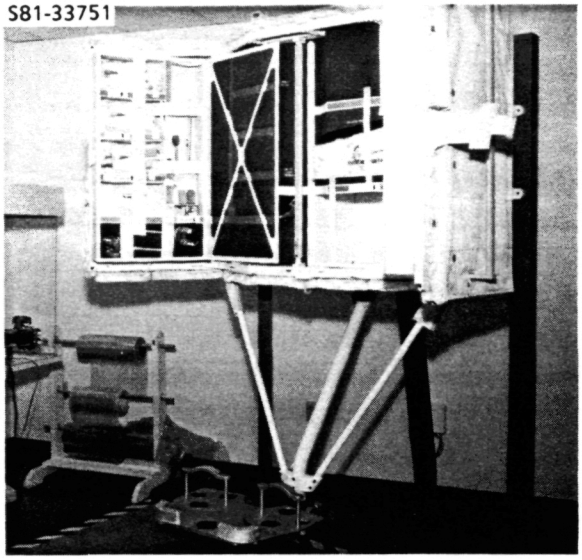
Dimensional Data	
A	2.56 in.
B	4.69 in.
C	13.93 in.
D	1.00 in.





ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

CARGO BAY STOWAGE ASSEMBLY



OVERVIEW

The cargo bay stowage assembly (CBSA) is a tool stowage assembly which mounts to a get-away special (GAS) beam in the cargo bay. The CBSA is a double-doored, compartmentalized stowage assembly. The portable foot restraint is normally mounted at the bottom of the CBSA structure. The CBSA has a useful volume of 18.3 cubic feet and can contain a maximum weight of 400 pounds.

OPERATIONAL COMMENTS

Prior to the development of the provisions stowage assembly (PSA), the CBSA contained the tools that would be required in an unscheduled/contingency EVA situation in which the extravehicular crewmembers would be required to close the cargo bay doors. The CBSA has been replaced by the PSA for standard Orbiter tool stowage. One CBSA has been modified to become the special equipment stowage assembly (SESA), and two remaining CBSA's can be modified to carry mission-specific EVA tools for a scheduled EVA.

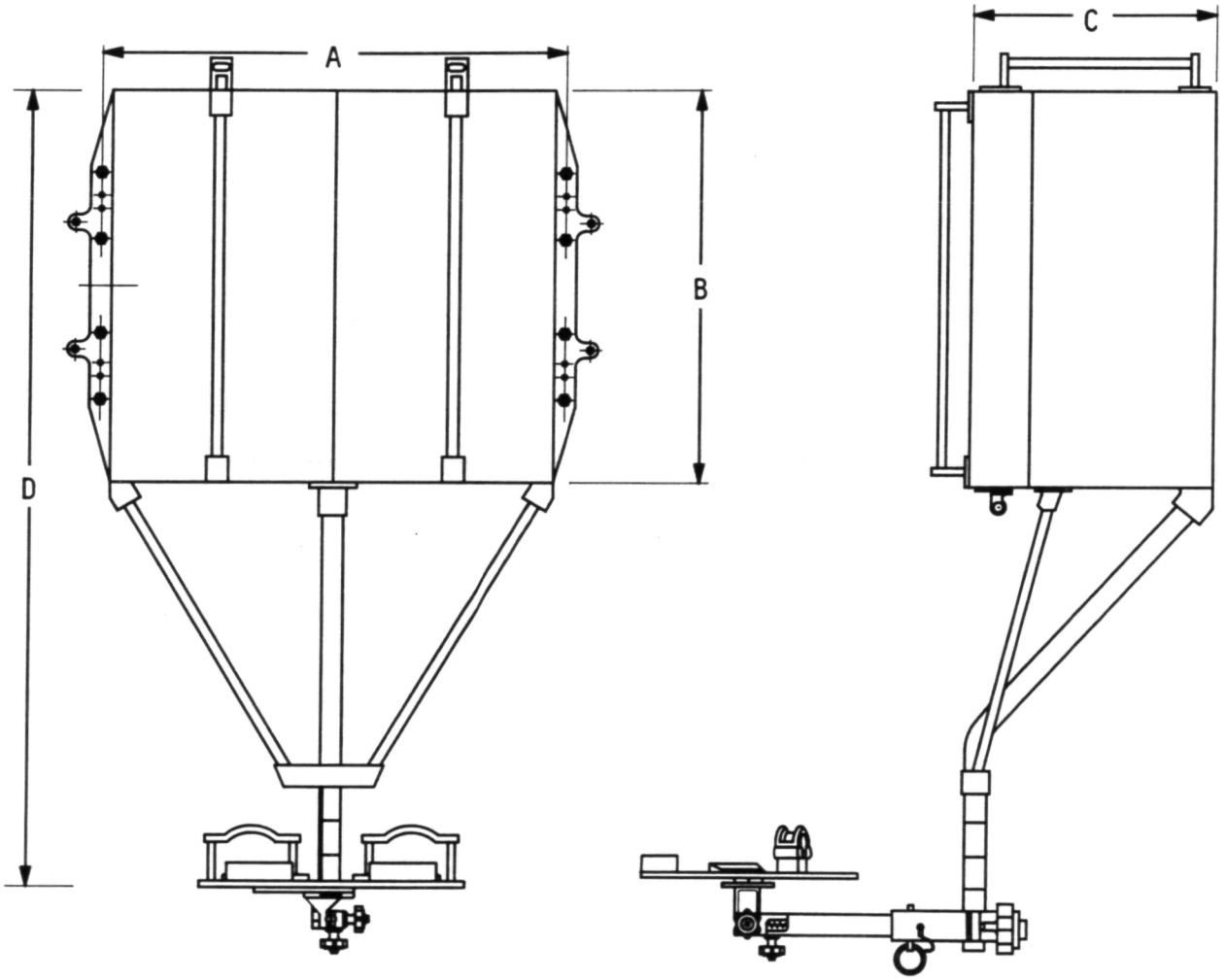
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: J. Madden, Rockwell/Houston, (713) 282-5300

CARGO BAY STOWAGE ASSEMBLY

Technical Information	
Part number	V567-340400
Weight	238.6 lb (without GAS beam)
Maximum content weight	469 lb
Material	Aluminum
Quantity flown	One for STS-2 through STS-13
Stowage area	18.3 ft^3
Availability	Flight specific

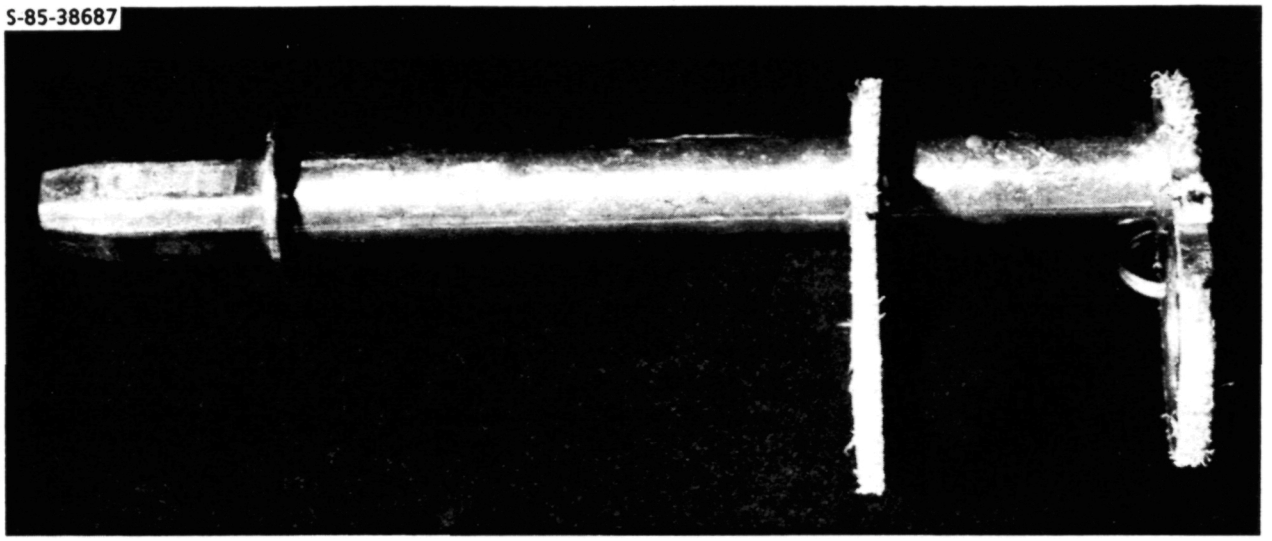
Dimensional Data	
A	42.0 in.
B	36.0 in.
C	22.0 in.
D	86.6 in.



204660037.ART, 2

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

CARRYOUT BRACKET



OVERVIEW

The carryout bracket is a support bracket designed specifically for Spacelab scientific airlock (SAL) unscheduled EVA's. It is a metal rod with two circular rings attached on one side and a tether ring attached on the other side.

OPERATIONAL COMMENTS

The carryout bracket is used only during Spacelab flights and only if there is a contingency EVA because of some failure in the retraction of the experiment table and/or closure of the SAL outer hatch. It is installed during the EVA on the experiment table by sliding the two circular rings over the experiment table jettison torque tube and then inserting the bracket base approximately 1 inch into the friction fit hole in the experiment table. The bracket prevents torque tube deflection and allows one-handed ratchet operation for disconnecting the experiment table.

This tool is part of the SAL generic EVA support equipment. It is stowed in the Spacelab tools caddy in Volume H locker of the crew compartment on a flight specific basis.

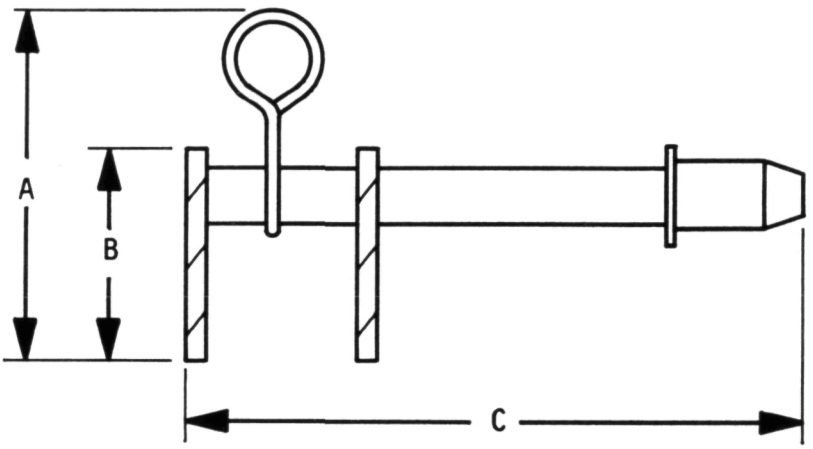
CONTACTS

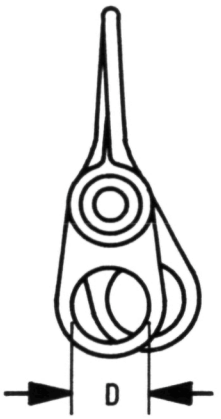
Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

CARRYOUT BRACKET

Technical Information	
Part number	10159-20077-01
Weight	0.22 lb
Material	Aluminum
Availability	Flight specific

Dimensional Data	
A	4.00 in.
B	2.45 in.
C	6.65 in.
D	0.75 in.

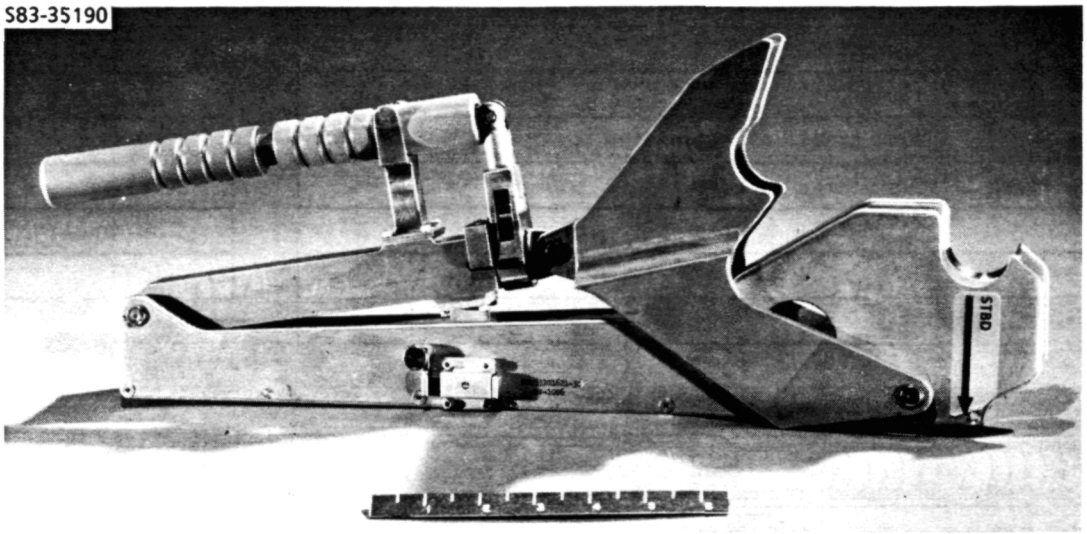




204660038.ART;3

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

CENTERLINE LATCH BYPASS TOOL



OVERVIEW

The centerline latch bypass tool consists of spring-loaded and fixed-load pickup points, a reversible ratchet with stowable handle, and release triggers which have a safety to prevent accidental release.

OPERATIONAL COMMENTS

The centerline latch tool is used to bypass a failed cargo bay door centerline latch. This tool is designed to exactly duplicate the nominal latch loads on the latch hook and roller. The frame of the tool fits over the latch hook pivot. With the frame held firmly in place, the tool latch is released, which in turn captures the latch roller. The tool handle is rotated to an upright position, and the drive is ratcheted to a hard stop, loading the tool and securing the latch. Two of these tools are part of the normally manifested STS equipment. Four tools would be flown for the first two flights of a new Orbiter. They are stowed in the centerline latch tool bag in the port provisions stowage assembly (PSA).

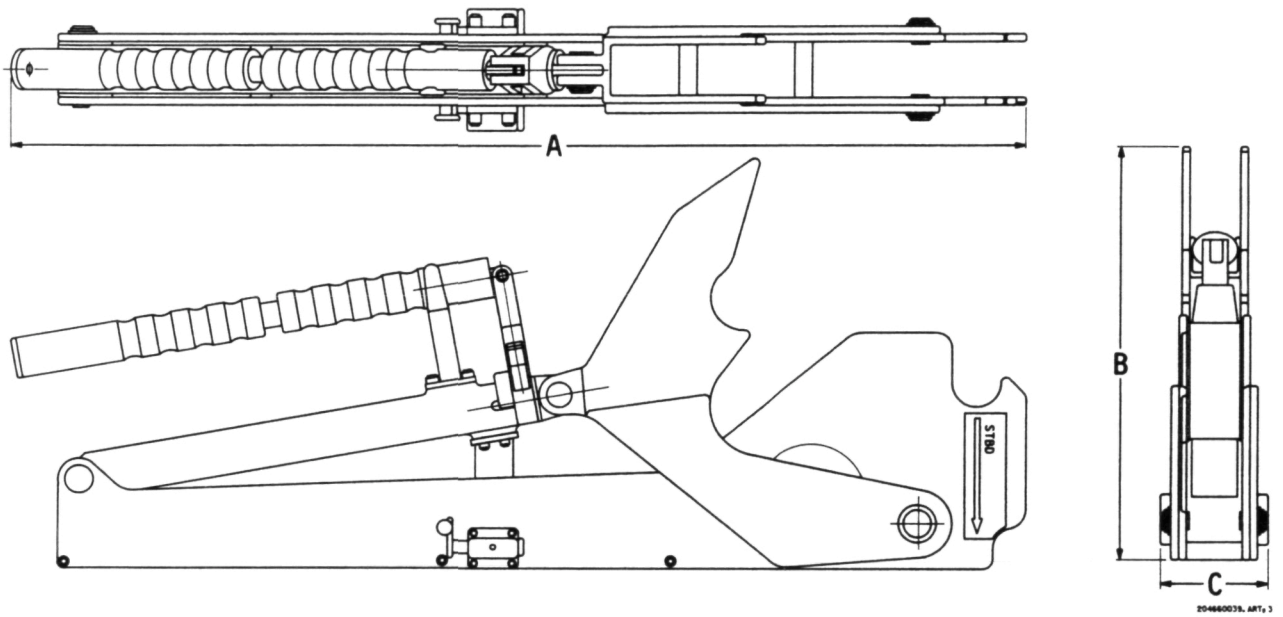
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: T. Ross, NASA/ES6, (713) 483-8941
Source: T. Ross, NASA/ES6, (713) 483-8941

CENTERLINE LATCH BYPASS TOOL

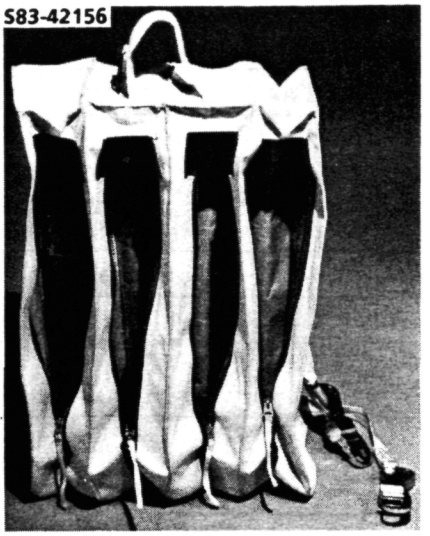
Technical Information	
Part number	SED33101621-305
Weight	11.45 lb
Material	4340 steel, nickel-plated
Quantity flown	Two stowed in port PSA
Availability	Standard

Dimensional Data	
A	19.60 in.
B	7.45 in.
C	2.49 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

CENTERLINE LATCH TOOL BAG



OVERVIEW

The centerline latch tool bag is used to store the centerline latch tools. It is equipped with two hooks for tether attachment to an EVA handrail near the worksite.

OPERATIONAL COMMENTS

The two-pocket bag is part of the normally manifested STS equipment and is stowed in the port provisions stowage assembly (PSA). The four-pocket bag is flown for the first two flights of a new Orbiter.

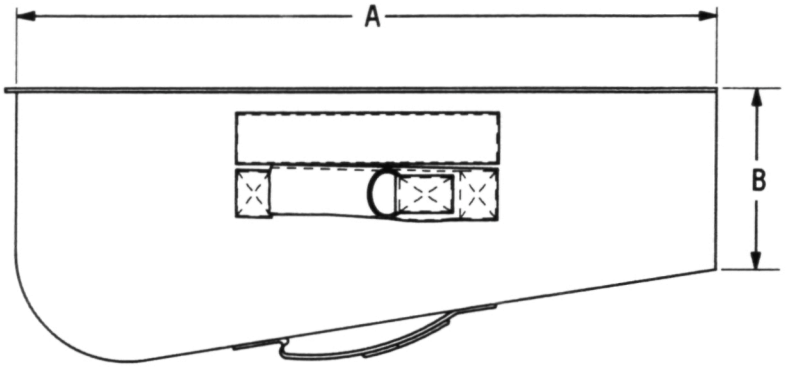
CONTACTS

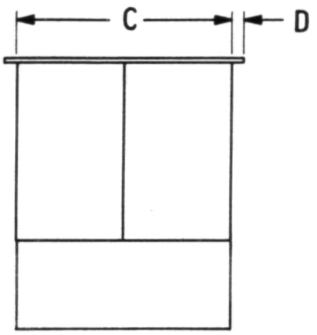
Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: J. Madden, Rockwell/Houston, (713) 282-5300

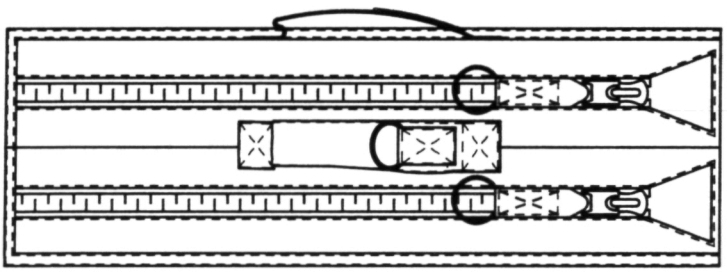
CENTERLINE LATCH TOOL BAG

Technical Information	
Part number	V633-669310-001 or -035 or SDD33103440-301
Weight	2.7 lb
Material	Nomex fabric, reinforced with Armalon
Temperature range	-200° to 250° F (operational)
Quantity flown	One in port PSA
Availability	Standard

Dimensional Data	
A	19.50 in.
B	5.00 in.
C	6.12 in.
D	0.25 in.



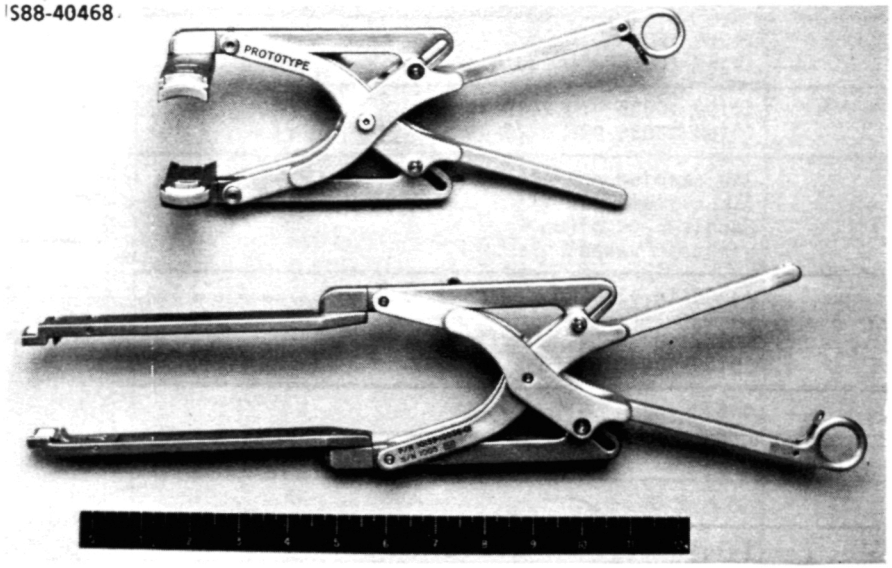




204660040. ART. 2

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

CIRCULAR CONNECTOR TOOL



OVERVIEW

The 0° circular connector tool (10159-10036-01) and the 90° circular connector tool (10159-10036-02) were originally developed for Centaur satellite-type electrical connectors. They have been designed for use on Hubble Space Telescope (HST) circular type connectors. The tools are used to install or remove connectors ranging from 1/2 inch to 2-1/8 inches in diameter.

OPERATIONAL COMMENTS

The 0° and 90° circular connector tools design utilizes parallel jaw action to grip the connectors. The crewmember can secure either tool as desired using the integral tether ring on the handle. A locking feature to hold the tool closed is incorporated into the handle for stowage purposes. The jaw surfaces are lined with silicone rubber to minimize abrasion of the connectors. A spring loaded retractable shoulder in each jaw aids connector installation.

The 90° circular connector tool is designed to simplify access to recessed connectors. The jaws extend at a 90° angle from the handle and are manipulated by parallel jaw action as the crewmember squeezes the handles together.

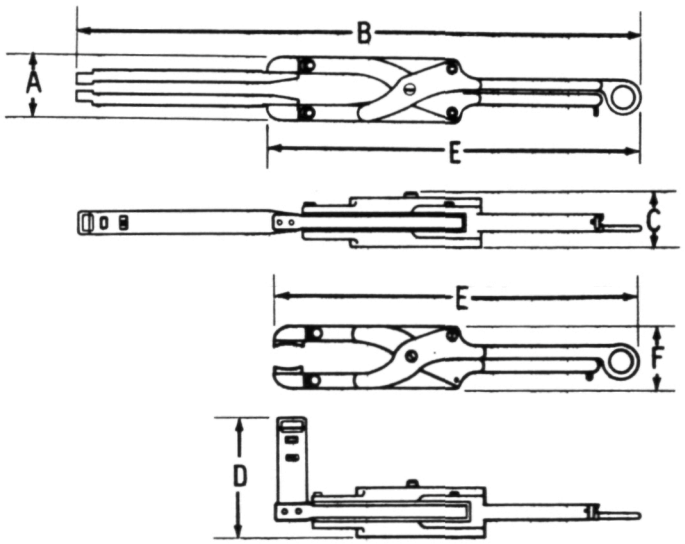
CONTACTS:

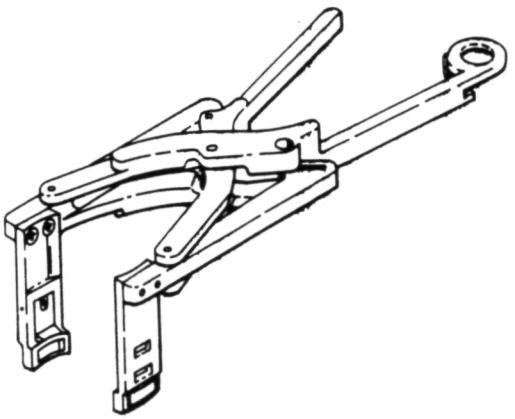
Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

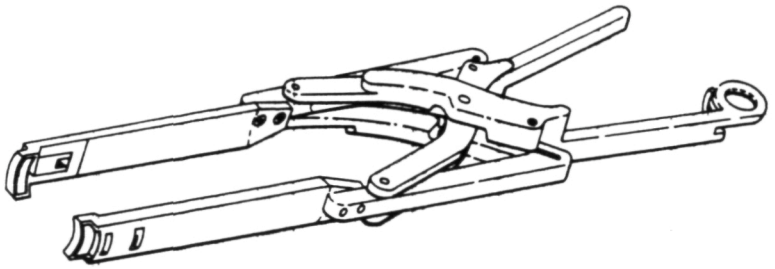
CIRCULAR CONNECTOR TOOL

Technical Information	
Part number	10159-10036-01 (0°) 10159-10036-02 (90°)
Weight	10159-10036-01 2.19 lb 10159-10036-02 1.73 lb
Material/ construction	Jaw cushion - silastic "E" rubber Jaw - stainless steel Handle - aluminum Washer - Vespel
Temperature range	-150° to +250° F (operational)
Jaw opening	10159-10036-01 0.5 to 1.85 in. 10159-10036-02 0.5 to 1.97 in.
Minimum grip	0.573 in.
Availability	Flight specific

Dimensional Data	
A	2.00 in.
B	17.65 in.
C	1.74 in.
D	4.00 in.
E	11.65 in.
F	2.00 in.

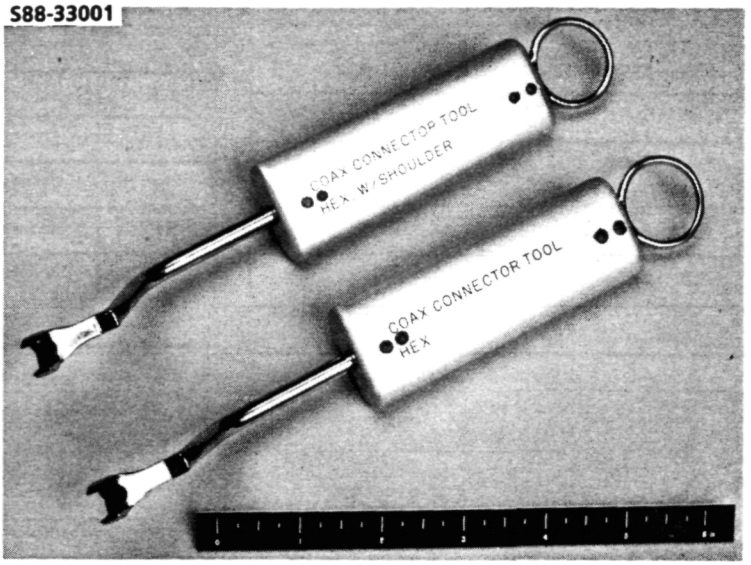






ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

COAX CONNECTOR TOOL



OVERVIEW

The coax connector tools have been designed for use on the Hubble Space Telescope (HST). They are used to install and remove 5/16-inch hex coax connectors. The coax connector tool (10181-10011-01) is specially designed without a shoulder to enable mating with those connectors having shrink tubing relief. The coax connector tool with shoulder (10181-10011-02) has an integral shoulder that allows improved connector seating pressure when installing connectors that have adequate clearance.

OPERATIONAL COMMENTS

The coax connector tools have a special shaft shaped to provide greater accessibility to confined areas. The handle design is similar in cross section to that of the standard handrail tubing so that the crewmember can grasp the tool securely. Crewmembers can tether the tool to their work stations or to themselves using the tether ring on the handle.

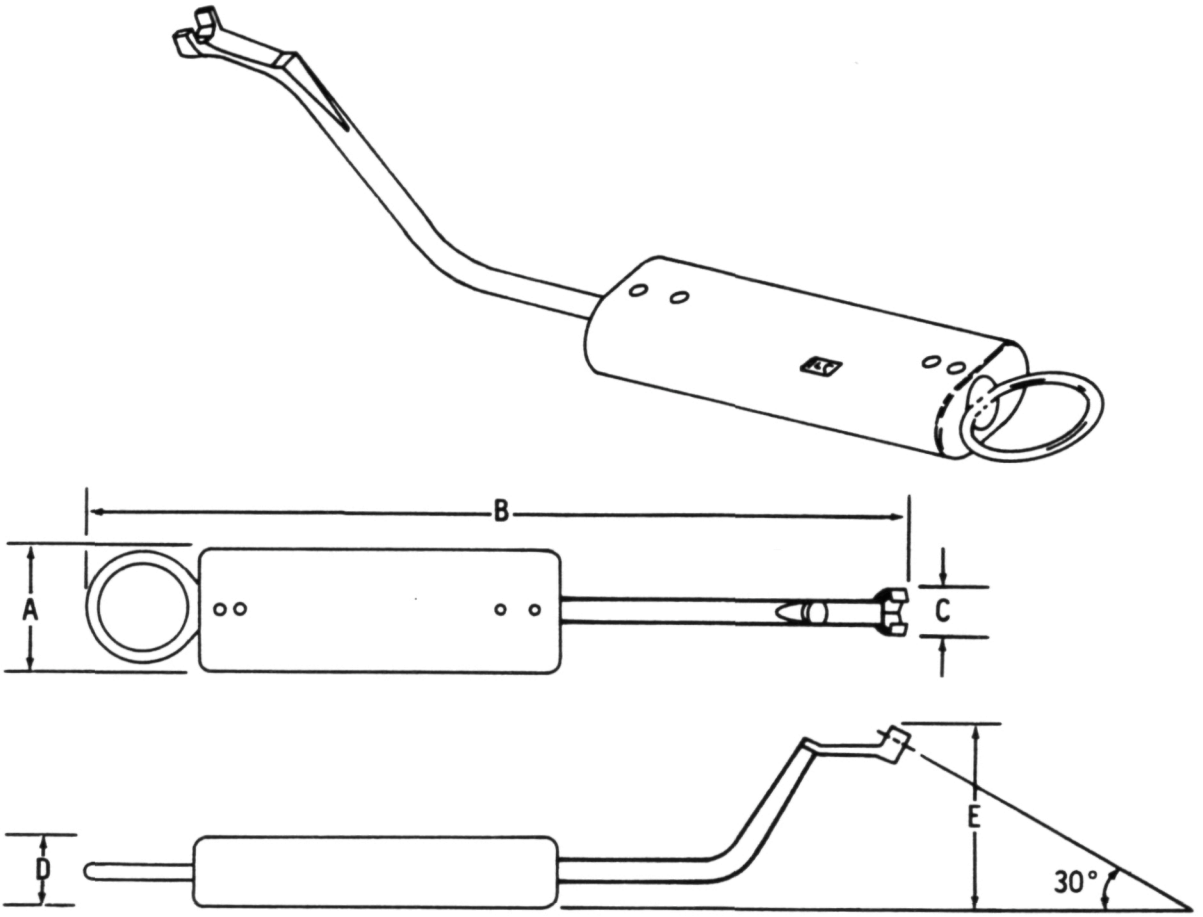
CONTACTS:

Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

COAX CONNECTOR TOOL

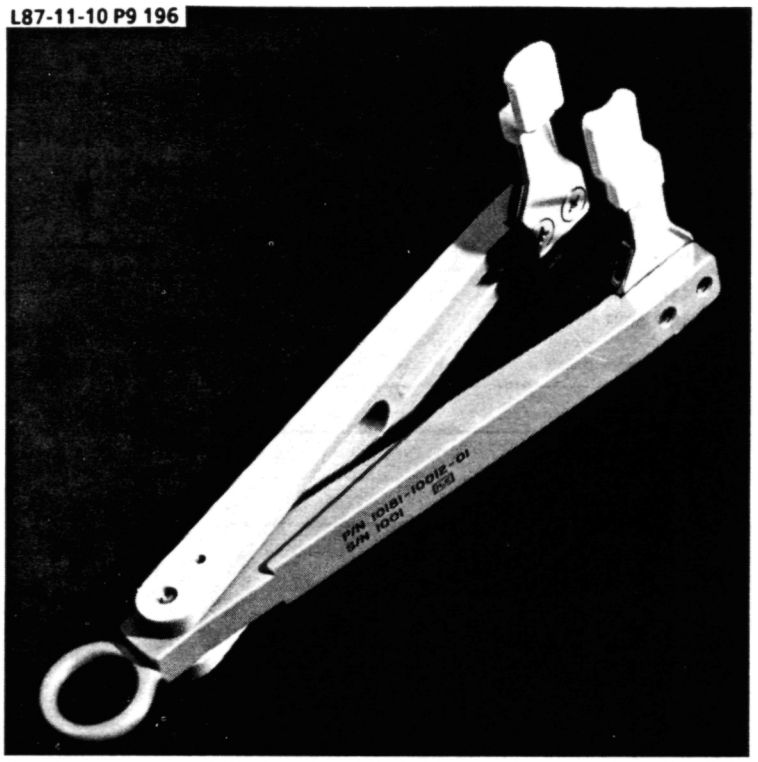
Technical Information	
Part number	10181-10011-01 without shoulder 10181-10011-02 with shoulder
Weight	0.44 lb
Material/ construction	Aluminum Stainless steel
Temperature range	-150° to +250° F
Force/torque	32.0 in-lb
Availability	Flight specific

Dimensional Data	
A	1.38 in.
B	9.16 in.
C	0.50 in.
D	0.75 in.
E	2.06 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

COAX CONNECTOR TOOL, ROUND



OVERVIEW

The round coax connector tool is designed for use on the Hubble Space Telescope (HST). The tool is used to remove and install coax connectors.

OPERATIONAL COMMENTS

The round coax connector tool closes the grip surfaces around the coax connector by manipulating the tool handles like tongs. The grip surfaces themselves are lined to minimize abrasion and maximize grip. The tool is designed to grip objects from 0.25 inch to 0.9 inch in diameter.

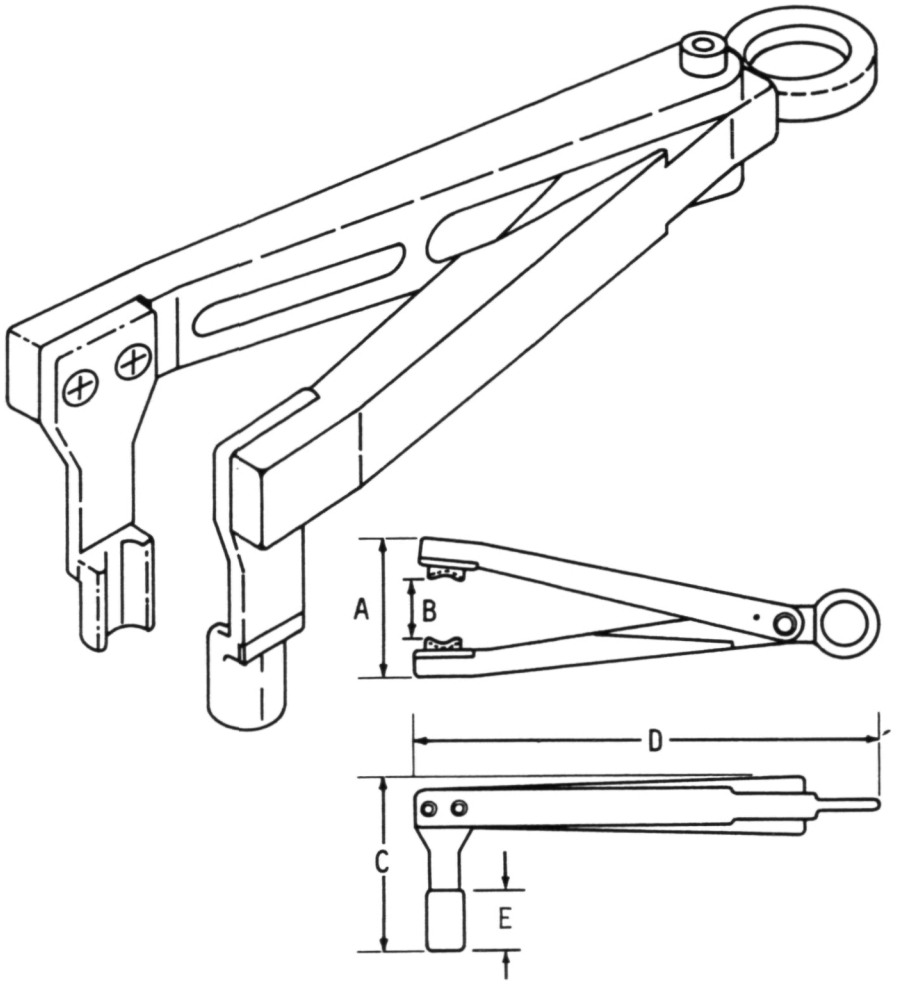
CONTACTS:

Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

COAX CONNECTOR TOOL, ROUND

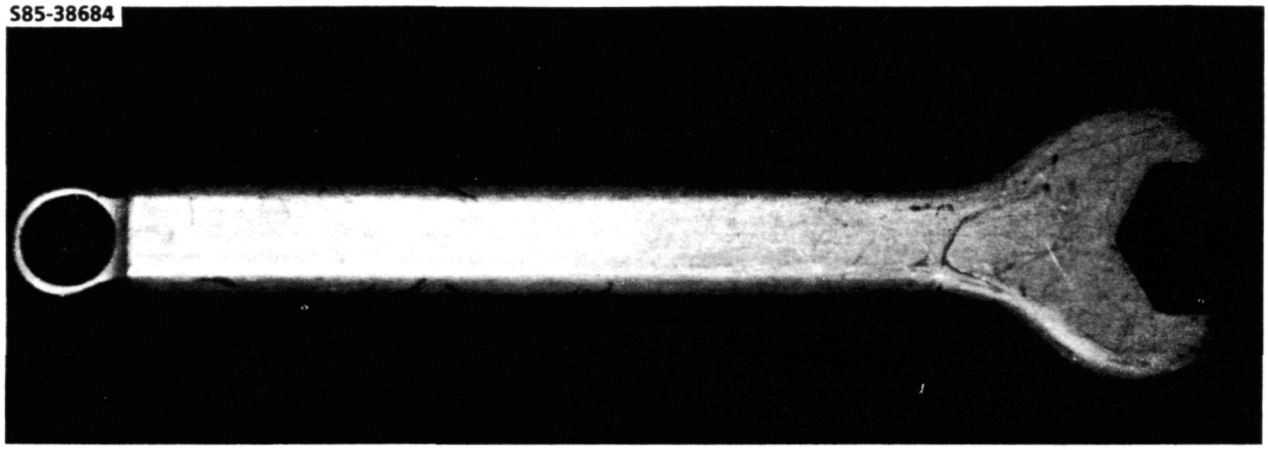
Technical Information	
Part number	10181-10012-01
Weight	0.49 lb
Material/ construction	Jaw cushion - silastic "E" rubber Jaw - stainless steel Handle - aluminum
Temperature range	-150° to +250° F (operational)
Jaw opening	Minimum - 0.25 in. Maximum - 0.90 in.
Jaw grip length	0.80 in.
Availability	Flight specific

Dimensional Data	
A	2.25 in.
B	0.20 in. min. 0.80 in. max.
C	2.88 in.
D	7.75 in.
E	1.00 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

CONTINGENCY STRUT WRENCH



OVERVIEW

The contingency strut wrench is basically a large open end wrench. The opening is 2.26 inches. The length of the wrench, with a tether ring at the end, is 20.5 inches.

OPERATIONAL COMMENTS

The contingency strut wrench was designed to tighten down lock nuts which secure the instrument pointing system (IPS) payload for landing in the event of IPS payload clamp assembly (PCA) failure. The tool is a payload-unique device and is not normally flown.

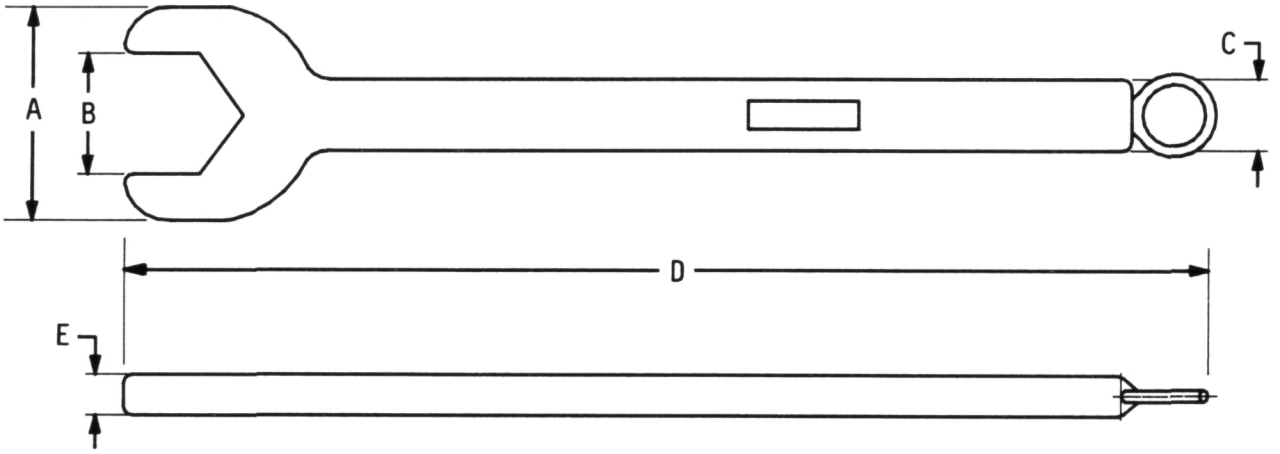
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: M. Naderi NASA/MSFC, (205) 544-2196
Source: Dornier Space Systems, Germany

CONTINGENCY STRUT WRENCH

Technical Information	
Part number	9005043
Weight	2.5 lb
Material/ construction	Aluminum, tether ring at end
Temperature range	-150° to 250° F
Availability	Flight specific

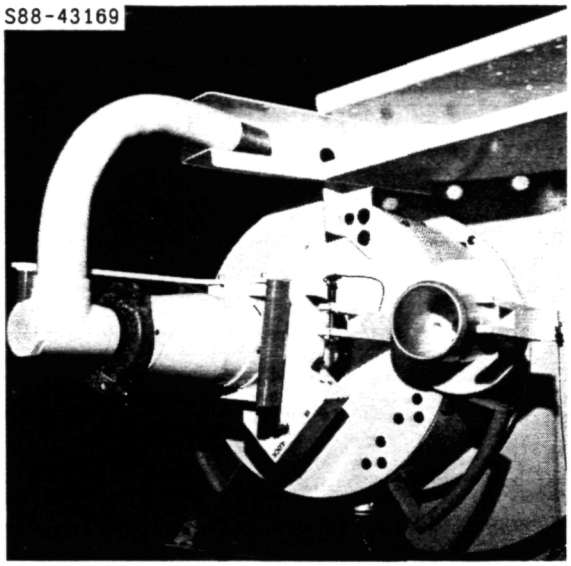
Dimensional Data	
A	4.40 in.
B	2.26 in.
C	1.25 in.
D	20.60 in.
E	0.75 in.



204660041.ORT; 5

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

COUPLING, HELIUM II RESUPPLY



OVERVIEW

The Helium II Resupply Coupling has been designed to allow the resupplying of cyrogenic superfluid helium (He II) tanks. This capability will extend the life of scientific instruments on future satellites. This coupling will be the EVA fluid connection between a He II supply tanker and a receiving spacecraft for the transfer of superfluid helium at temperatures less than 18° K. The coupling is currently being developed to support the superfluid helium on-orbit transfer (SHOOT) flight experiment as a technology demonstration mission.

OPERATIONAL COMMENTS

This coupling consists of a tanker half (type 1) and a spacecraft half (type 2). For manual EVA engagement, the EVA crewmember initially connects the two halves in a "soft dock" position. A 7/16-inch drive hex is then used to fully engage the coupling halves. An electrical switch provides engagement status to the ground and Orbiter aft flight deck. When the two halves are engaged, fluid transfer is possible. This procedure is reversed to disengage the coupling.

The coupling will initially be used for manual EVA mate and demate on orbit, but shall be readily modifiable for automatic operation when used with a carrier plate. For the SHOOT flight experiment and the initial superfluid helium tanker resupply missions, a power tool will be used to drive a 7/16-inch hex which controls the mate/demate drive screw. Type 2 couplings will be installed on the advanced X-ray astronomical facility (AXAF) and the Shuttle infrared telescope facility (SIRTF).

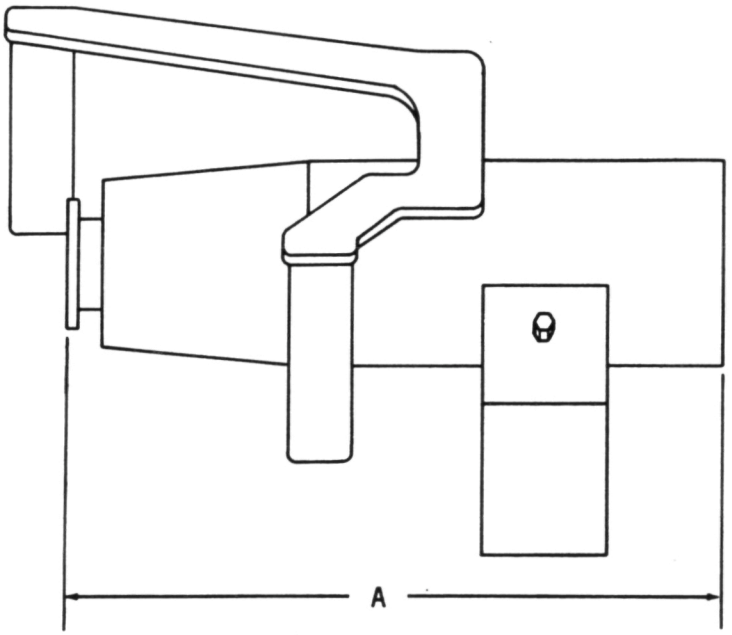
CONTACTS

Operational: R. C. Trevino, NASA/DF4, (713) 483-2597
Technical: W. C. Boyd, NASA/EP4, (713) 483-9020
Source: M. Chaves, Jr., Moog Inc., Space Products Div., (716) 687-4995

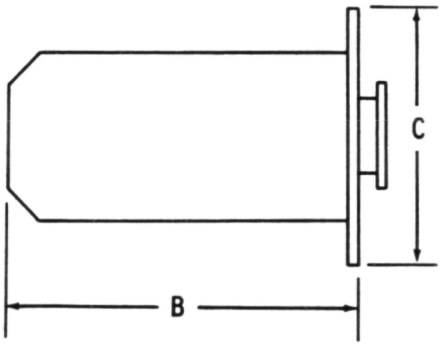
COUPLING, HELIUM II RESUPPLY

Technical Information	
Part number	None
Weight	31 lb (estimate)
Material	Stainless steel
Drive torque	~25 in-lb
Drive turns	24.2 in.
Temperature range	-258° to +170° F
Availability	Developmental

Dimensional Data	
A	13.91 in.
B	10.02 in.
C	6.91 in.



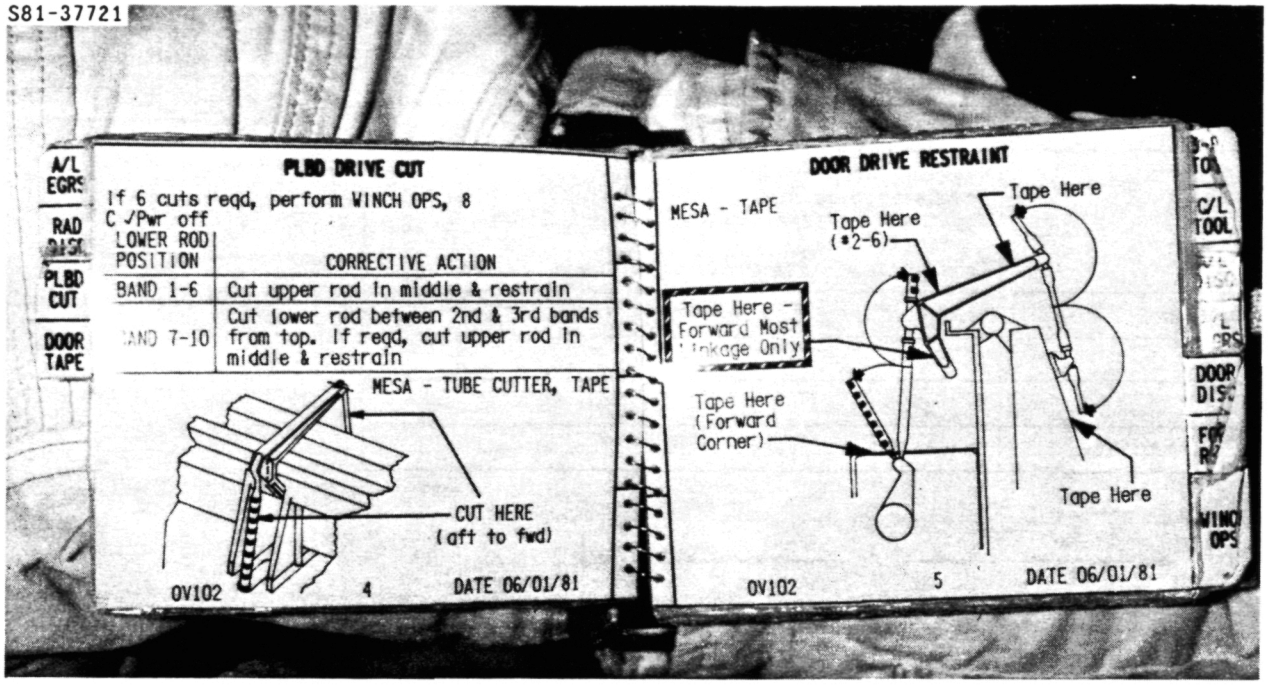
TYPE I



TYPE II

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

CUFF CHECKLIST



OVERVIEW

The cuff checklist is a set of reference cards which are bound and attached to a wristband. The reference cards are approximately 4 inches by 5 inches in size and contain procedures and reference data for performing EVA tasks. The cuff checklist also contains procedures which aid in the diagnosis and resolution of an extravehicular mobility unit (EMU) failure. Each card has an indexing tab for easy card location.

OPERATIONAL COMMENTS

The checklist is worn below the left elbow of the EMU and is approximately 0.5 inch thick when closed. Pages can be added for flight-specific EVA tasks.

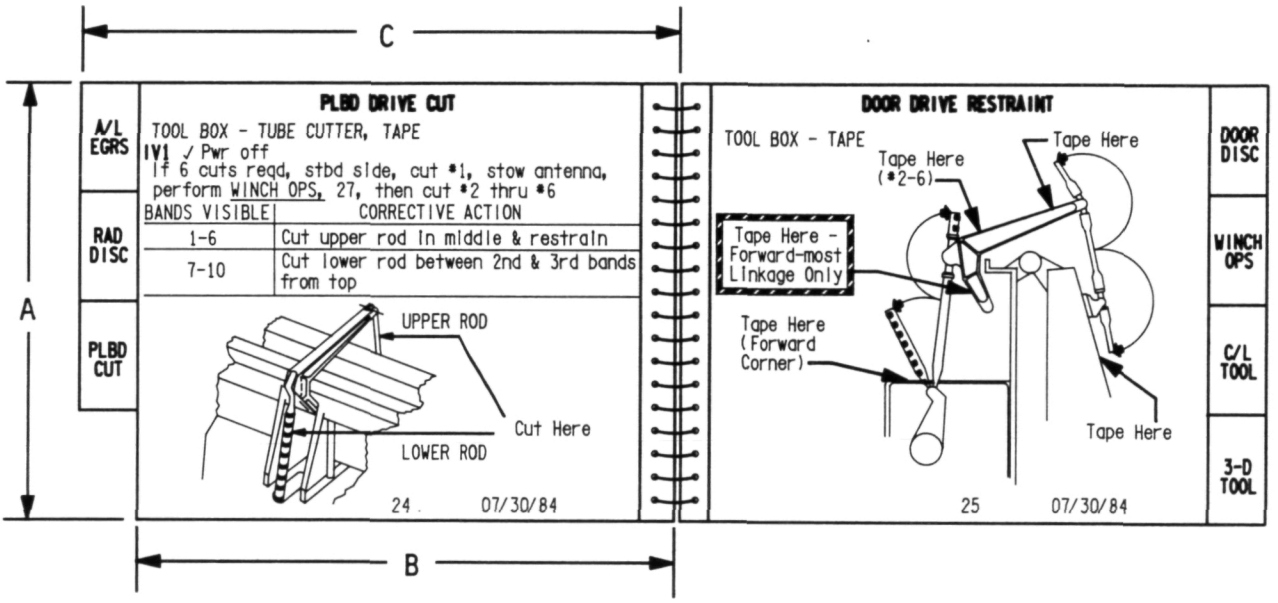
CONTACTS

Operational: C. H. Armstrong, NASA/DF42, (713) 483-2588
Technical: R. D. Snyder, NASA/DH, (713) 483-4487
Source: R. D. Snyder, NASA/DH, (713) 483-4487

CUFF CHECKLIST

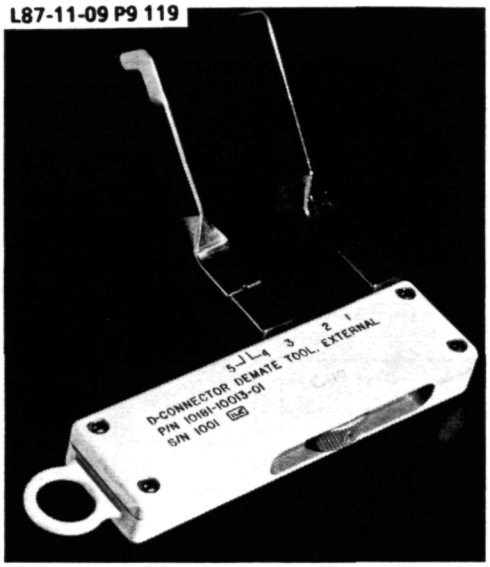
Technical Information	
Part number	SEB33100302-307 (arm band) SEB33100302-330 (leaf spring)
Weight	0.6 lb
Material	Pages - chronopaque Bracket - aluminum Wristband - steel Twistoflex with Ortho fabric cover Coil spring - stainless steel wire
Quantity flown	One each for EMU 1 and EMU 2
Availability	Standard

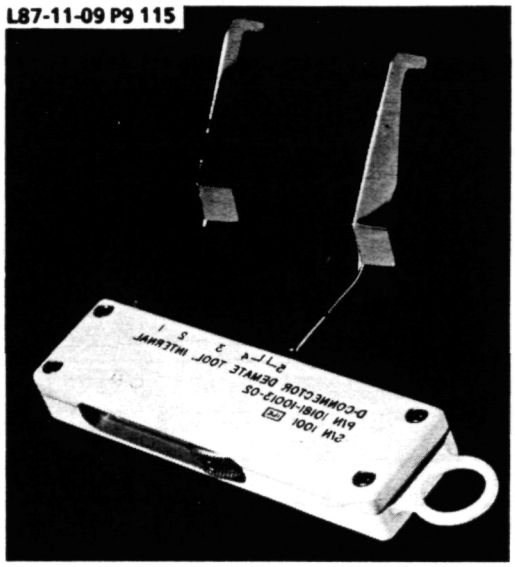
Dimensional Data	
A	3.8125 in.
B	4.5000 in.
C	5.0000 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

D-CONNECTOR DEMATE TOOL





OVERVIEW

The external D-connector demate tool (10181-10013-01) is used for removal of electrical connectors on the Hubble Space Telescope (HST) which are mounted with external flanges. The internal D-connector demate tool (10181-10013-02) is used for removal of electrical connectors on the HST which are mounted with internal flanges. The blades are adjustable for removal of 9-, 16-, 29-, 37-, and 50-pin D-connectors.

OPERATIONAL COMMENTS

These tools are suitable for one-handed removal of electrical connectors by a suited crewmember. The tools consist of a handle and two L-shaped hook blades which extend from the handle. The L-shaped blade design allows access to hard-to-reach areas. One of the blades can be moved along the handle length by simultaneously depressing and sliding the button on the handle face. The hooks on the ends of the blades are positioned under the connector flange in order to pry the connector loose. Each of the blades can be rotated 180° so the tool can be used in confined areas with obstructions on either the left or right sides of the connectors.

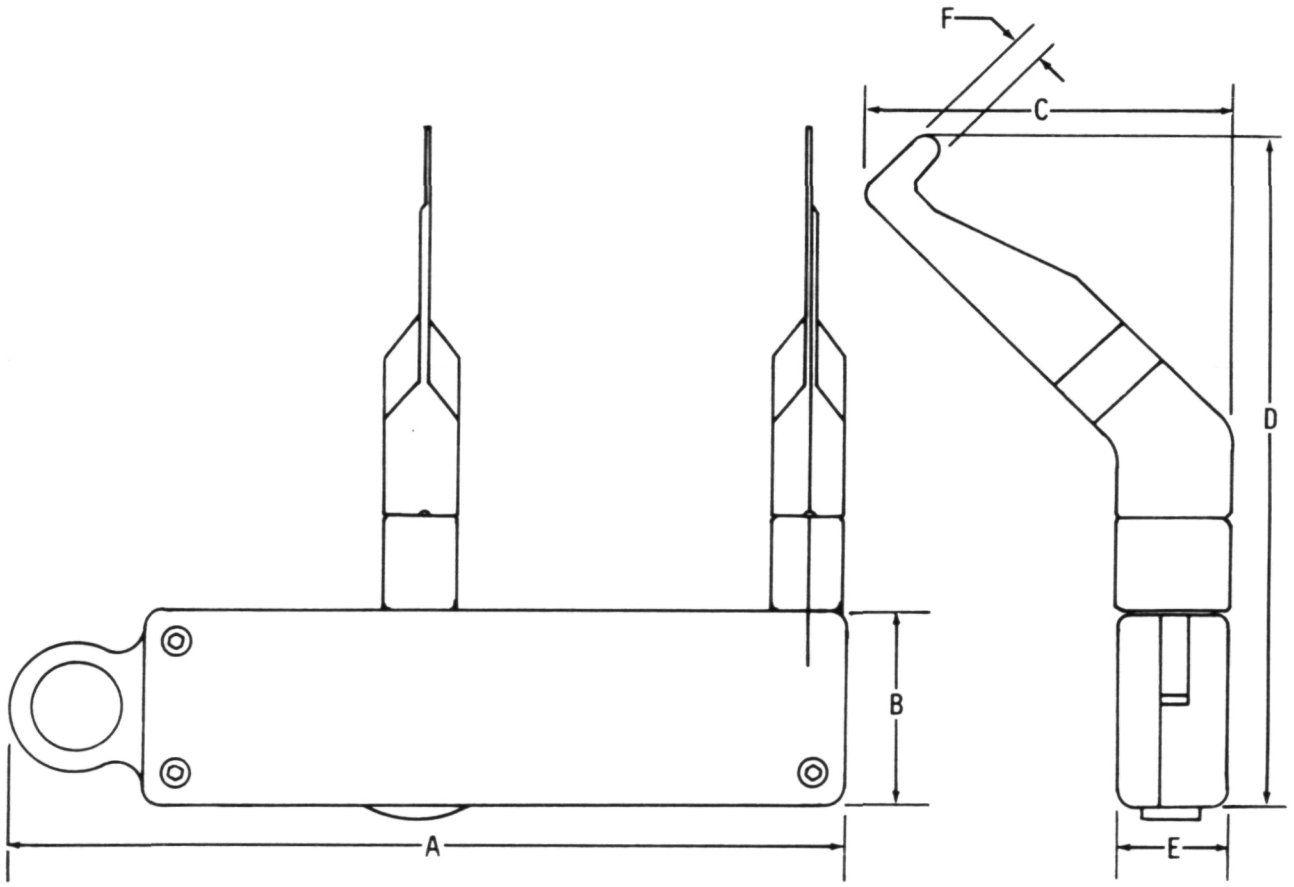
CONTACTS

Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

D-CONNECTOR DEMATE TOOL

Technical Information	
Part number	10181-10013-01 External 10181-10013-02 Internal
Weight	0.75 lb
Material/ construction	Stainless steel Aluminum
Distance between prong hooks	Position 1 0.800 in. 2 1.125 in. 3 1.671 in. 4 2.210 in. 5 2.315 in.
Temperature range	-150° to +250° F
Availability	Flight specific

Dimensional Data	
A	5.700 in.
B	1.380 in.
C	2.500 in.
D	4.930 in.
E	0.750 in.
F	0.235 in. (-01)
	0.172 in. (-02)



D-CONNECTOR MATE TOOL

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

OVERVIEW

The D-connector mate tool is used for installation of electrical connectors on the Hubble Space Telescope (HST). The tool is adjustable to fit 9-, 16-, 29-, 37-, and 50-pin "D"-connectors.

OPERATIONAL COMMENTS

The D-connector mate tool is suitable for one-handed operation. The tool consists of a handle and two I-shaped blades which extend from the handle. One of the blades can be moved along the handle length by simultaneously depressing and sliding the button on the handle face. The blade ends are shaped to grip the flanged ends of the connectors. Each blade can be rotated 180° so that the tool can be used in confined areas with obstructions on either the left or right sides of the connectors. The blade ends are positioned over the connector to secure it as it is put into place.

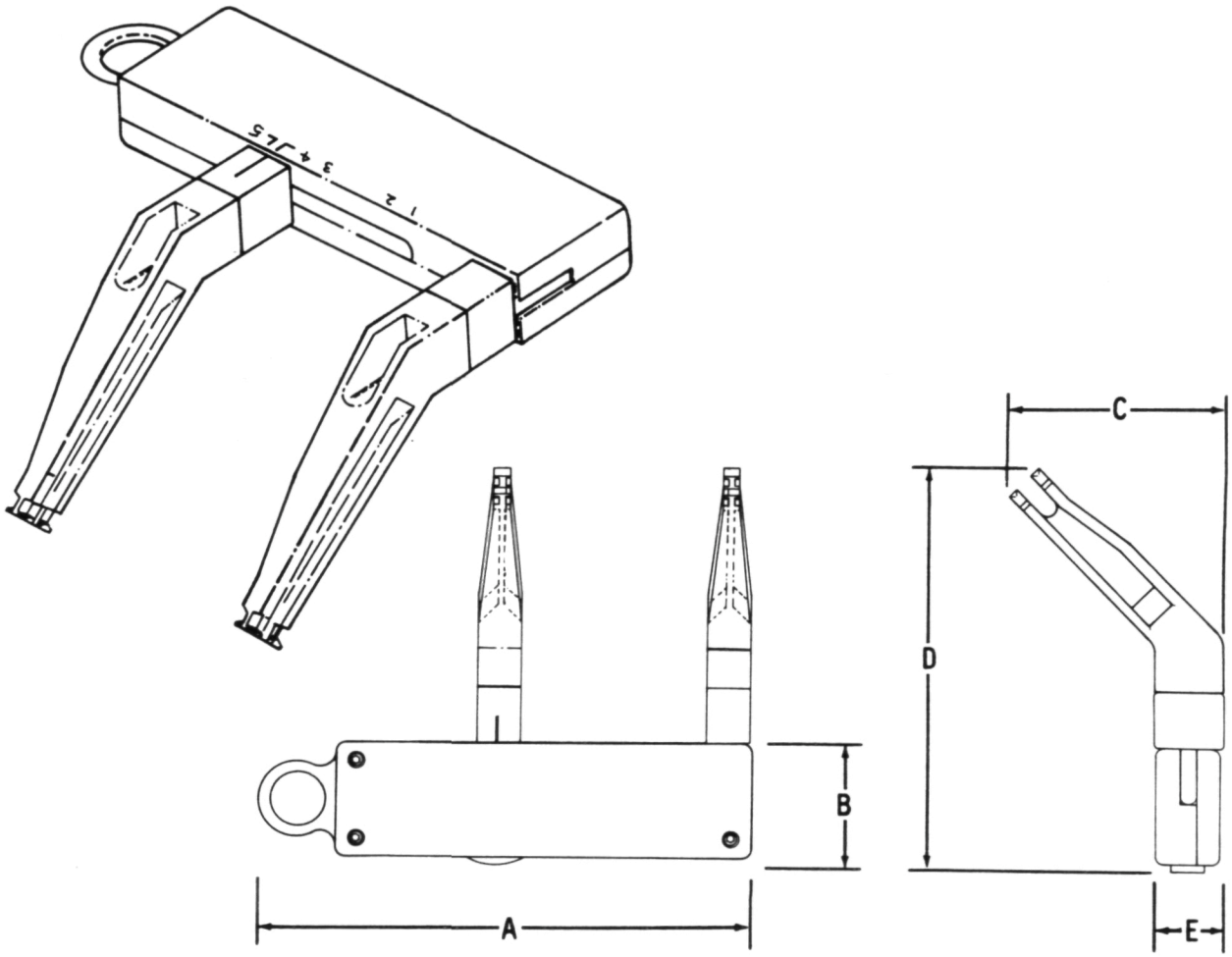
CONTACTS

Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

D-CONNECTOR MATE TOOL

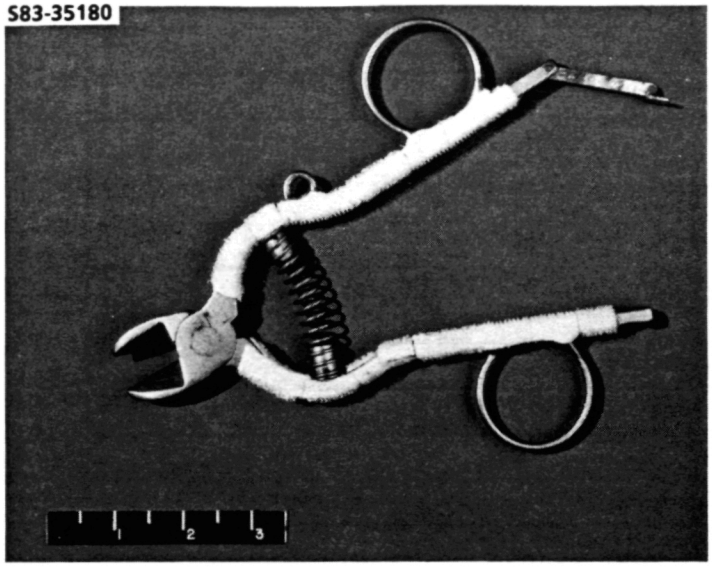
Technical Information	
Part number	10181-10014-01
Weight	0.93 lb
Material/ construction	Aluminum Stainless steel
Distance between prong hooks	1 1.230 in. 2 1.550 in. 3 2.100 in. 4 2.650 in. 5 2.736 in.
Temperature range	-150° to +250° F
Availability	Flight specific

Dimensional Data	
A	5.70 in.
B	1.38 in.
C	2.49 in.
D	4.78 in.
E	0.75 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

DIAGONAL CUTTERS



OVERVIEW

The diagonal cutters have 1-inch blades with a maximum opening of 7/8 inch. They have finger rings designed to fit the crewmember's gloved hand, a latch to hold the handle in the closed position, a spring to force the handles apart, and a ring for tether attachment. A rubber insert has been added to the cutting blades to help in gripping items to be cut.

OPERATIONAL COMMENTS

The diagonal cutters can be used as a disconnect and jam removal tool. They are a general usage tool with no specific, designated tasks. This tool is part of the normally manifested STS equipment. It is wrapped in a Velcro-lined tool caddy along with the needle nose pliers and stowed in the starboard provisions stowage assembly (PSA).

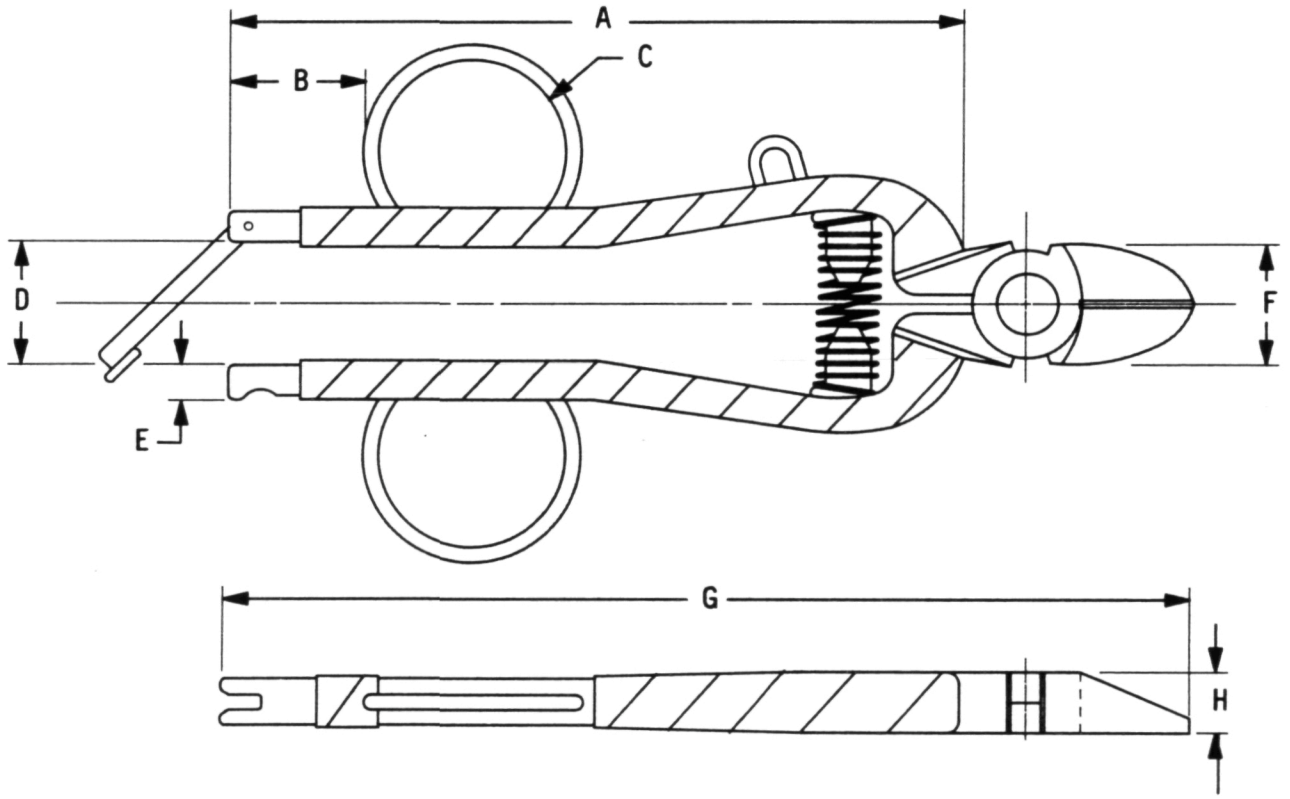
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: J. Madden, Rockwell/Houston, (713) 282-5300

DIAGONAL CUTTERS

Technical Information	
Part number	V628-650866-018 or SDD33103437-301
Weight	0.6 lb
Material/ construction	AISI 4063 steel, RC 40 to 45 Cutting edge - RC 61 ± 2 Handles - Velcro-wrapped, tether ring on one
Maximum opening	7/8 in.
Temperature range	-200° to 250° F (operational)
Quantity flown	One in the starboard PSA
Availability	Standard

Dimensional Data	
A	6.000 in.
B	1.125 in.
C	0.750 in.
D	1.000 in.
E	0.250 in.
F	1.000 in.
G	7.880 in.
H	0.500 in.



204660043.ART, 2

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

DOOR STAY, ADJUSTABLE, SSM

OVERVIEW

The systems support module (SSM) adjustable door stay is designed to secure the bay doors on the Hubble Space Telescope (HST) in an opened position. The stay will adjust to fit any SSM bay door that does not have an integral door stay. The stay can also be used in addition to the integral door stay at the opposite end of the door hinge line in cases where greater door stability is desired.

OPERATIONAL COMMENTS

The SSM adjustable door stay interfaces on one end with screws that extend out from the door frame. The other end latches over the J-hook screws. There are 15 possible length adjustments at 1/2-inch increments. The stay can range from 16-3/4 inches to 24-1/4 inches. An integral tether ring provides a restraint attachment point.

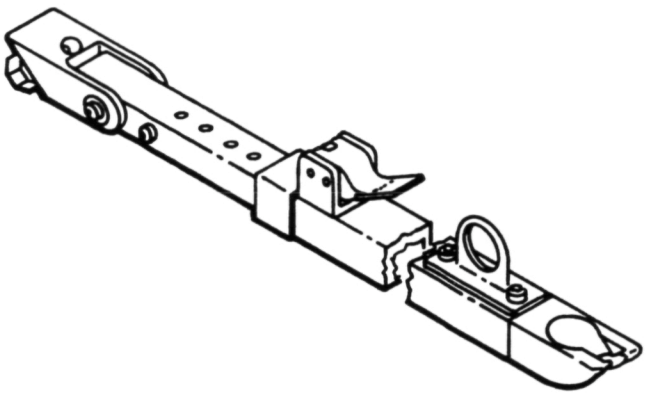
CONTACTS

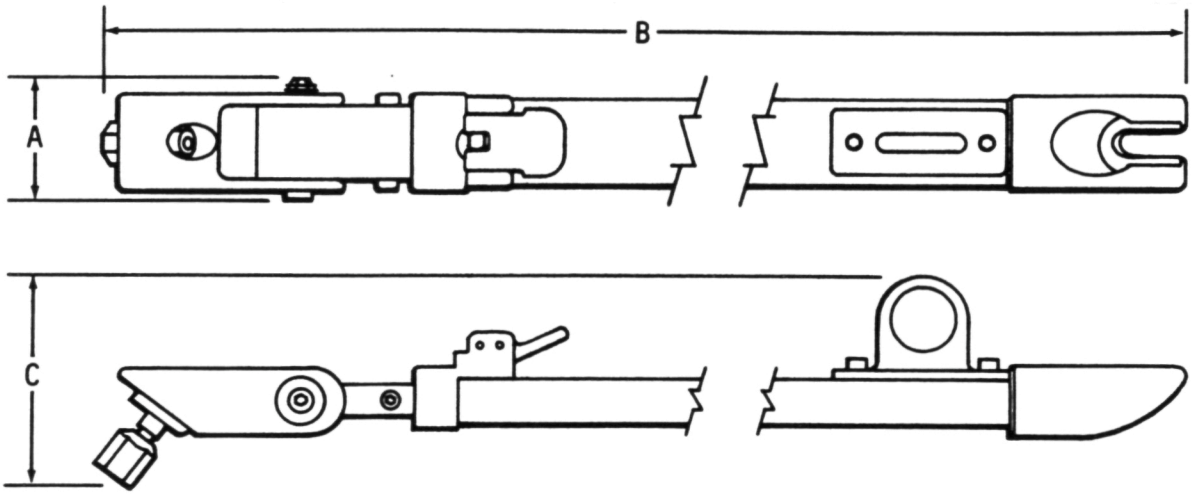
Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

DOOR STAY, ADJUSTABLE, SSM

Technical Information	
Part number	10181-10010-01
Weight	0.80 lb
Material/ construction	Aluminum Stainless steel
Temperature range	-150° to +250° F
Availability	Flight specific

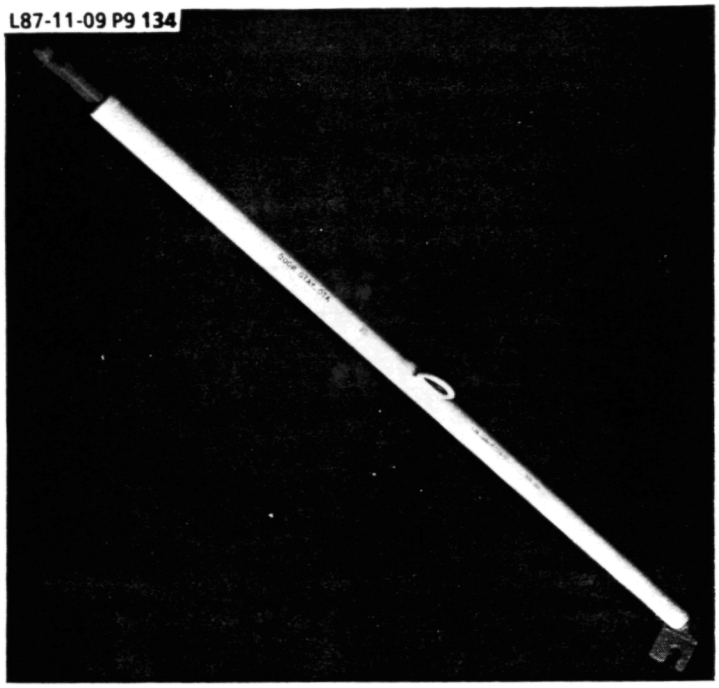
Dimensional Data	
A	1.40 in.
B	16.80 in. retracted 24.30 in. extended
C	2.60 in.





ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

DOOR STAY, OTA



OVERVIEW

The optical telescope assembly (OTA) door stay is designed specifically to secure the bay C door in the OTA section of the Hubble Space Telescope (HST) in an opened position.

OPERATIONAL COMMENTS

The door stay is made to secure the bay C door open at 118°. It is used by inserting one end through one of the door holes and securing the forked end under a J-bolt head. An integral tether ring provides a restraint attachment point.

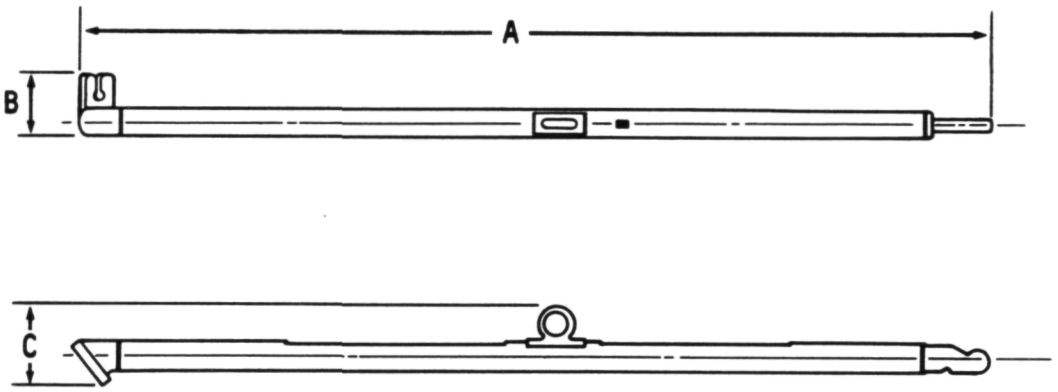
CONTACTS

Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

DOOR STAY, OTA

Technical Information	
Part number	10181-10009-01
Weight	0.53 lb
Material/ construction	Aluminum
Temperature range	-150° to +250° F
Availability	Flight specific

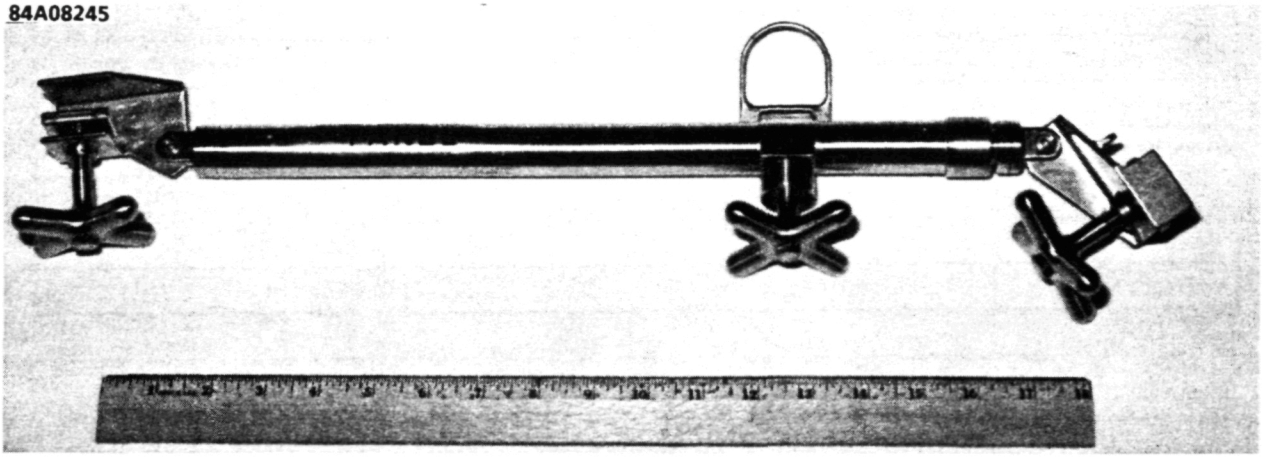
Dimensional Data	
A	25.70 in.
B	1.76 in.
C	2.25 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

DOOR SUPPORT BRACKET

84A08245



OVERVIEW

The door support bracket is a 20-inch telescoping tube with a swivel-motion bracket mounted at each end. Each end has an adjustable knob for tightening the bracket to the structure. The bar extends an additional 9 inches if needed. A tether ring is attached to the bar for easy transportation to a worksite.

OPERATIONAL COMMENTS

The door support bracket was used on the Solar Maximum Satellite (Solar Max) Repair Mission to hold open the main electronics box (MEB) panel. The support bracket was installed between the bottom of the MEB panel and the Solar Max frame. The MEB panel opened at approximately 90°, and the support bracket adjustment knob was tightened to maintain the MEB panel in the open position. This tool is not normally flown.

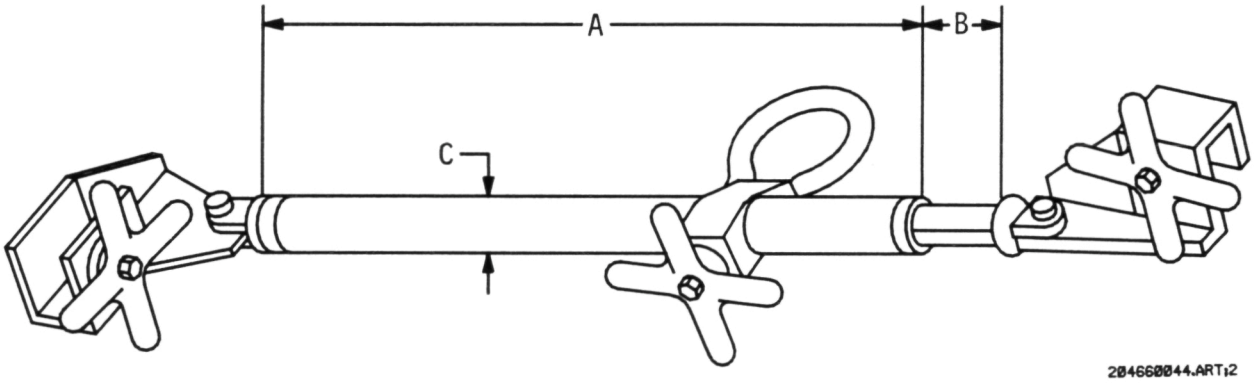
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: K. Olson, NASA/GSFC, (301) 286-3230
Source: K. Olson, NASA/GSFC, (301) 286-3230

DOOR SUPPORT BRACKET

Technical Information	
Part number	1418231
Weight	5.0 lb
Material	Stainless steel
Availability	Flight specific

Dimensional Data	
A	14.625 in.
B	9.000 in. max.
C	1.000 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

DRIVE UNIT PRELOAD TOOL

OVERVIEW

The drive unit preload tool is used for operation of the high gain antenna and aperture door manual deployment hinge of the Hubble Space Telescope (HST). It has a tether ring on one end and a hinge drive interface on the other end. The cross section of the hinge drive interface is D shaped.

OPERATIONAL COMMENTS

The drive unit preload tool is used to drive the output shaft of the rotary drive actuator to a mechanical stop. This will provide a preload on the aperture door and high gain antenna after manual deployment. Extravehicular activity (EVA) interface marking is provided on each hinge drive.

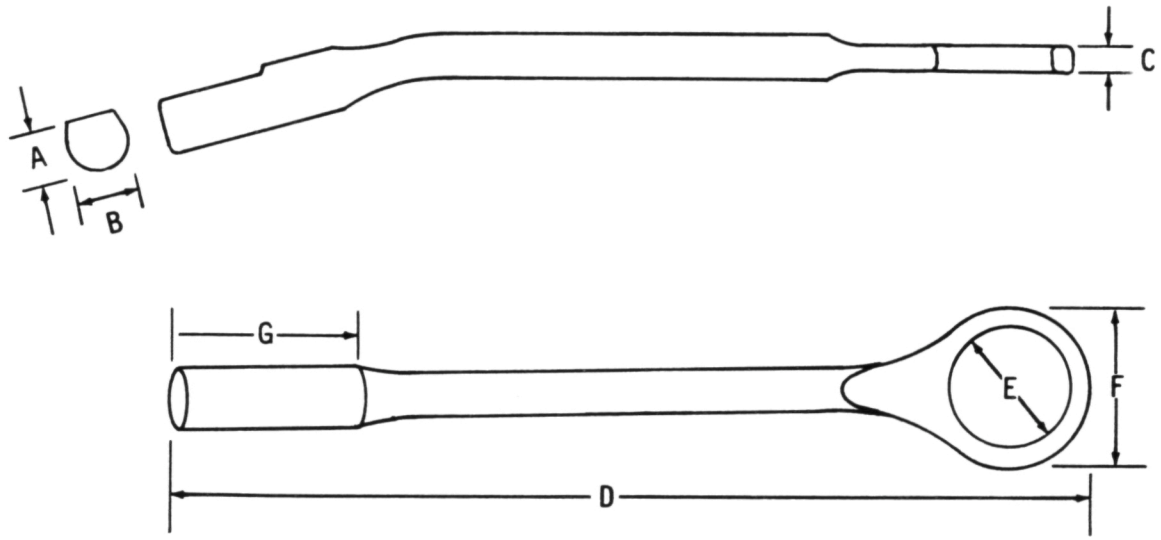
CONTACTS

Operational: S. P. Boyd, NASA/DF42, (713) 483-1755
Technical: H. T. Greenfield, LMSC/Dept 64-30, (408) 742-5799
Source: LMSC, HST Contracts Office, (408) 742-5505

DRIVE UNIT PRELOAD TOOL

Technical Information	
Part number	4177312
Weight	0.74 lb
Material	Stainless steel, 15-5 PH CRES
Availability	Flight specific

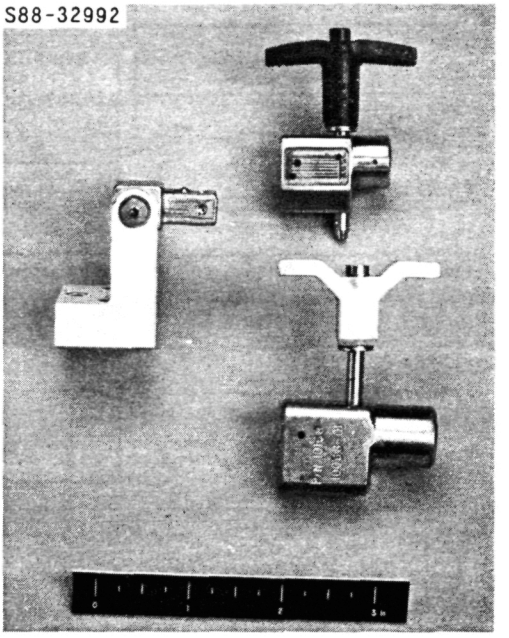
Dimensional Data	
A	0.620 in.
B	0.700 in.
C	0.300 in.
D	10.085 in.
E	1.310 in.
F	1.750 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

DROP-PROOF TETHER

S88-32992



OVERVIEW

The drop-proof tether, also called the self-tethering disconnect or the McTether, is a quick-disconnect device installed on many different tools. The drop-proof tether is the safest means of connecting tips, sockets, and drives to EVA tools equipped with a modified 3/8-inch square drive fitting. This system assures that sockets and extensions cannot be accidentally untethered and lost.

OPERATIONAL COMMENTS

When two tools are connected by drop-proof tethers, the male and female attachment devices are secured by a spring-loaded ball that can be released only by a pip pin. Installation requires that the pip pin be inserted before pushing the driver and drop-proof tether together. Removal requires insertion of the pip pin prior to pulling the two items apart.

Three drop-proof tether configurations currently exist. The construction of the original (10168-10068-01) has a female socket which is secured to drive tools by the installation of a spring pin. The smaller, lighter mini-McTether (10181-10003-03) is secured with a cryogenically installed capture pin. The third configuration (10181-10003-01) is pinned to a right-angle drive.

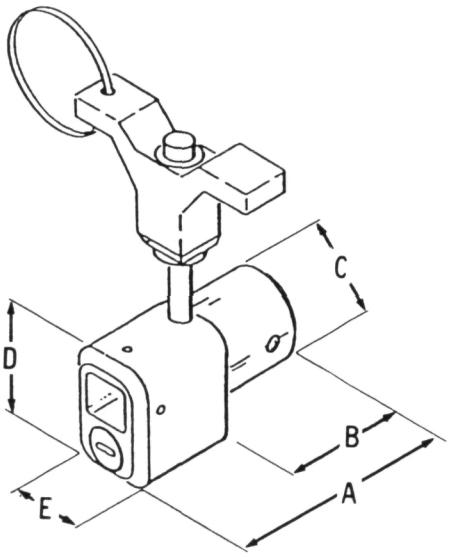
CONTACTS

Operational: R. C. Trevino, NASA/DF4, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-4336
Source: M. Withey, ILC Space Systems, (713) 488-9080

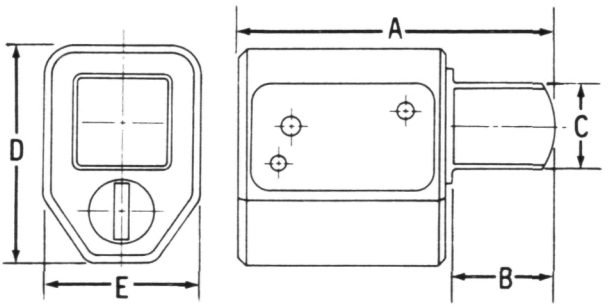
DROP-PROOF TETHER

Technical Information	
Part number	10168-10068-01 10181-10003-01/03
Weight	0.184 lb (10168-) 0.100 lb (10181-)
Material	Stainless steel
Temperature range	-130° to +150° F
Availability	Flight specific

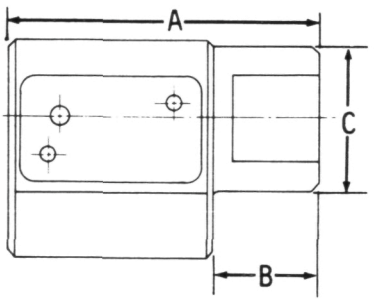
Dimensional Data			
10168-10068-01		10181-10003	
		-01	-03
A	1.70 in.	1.329 in.	1.329 in.
B	0.70 in.	0.422 in.	0.454 in.
C	0.70 in.	0.372 in.	0.640 in.
D	1.01 in.	0.930 in.	0.930 in.
E	0.70 in.	0.660 in.	0.660 in.



10168-10068-01



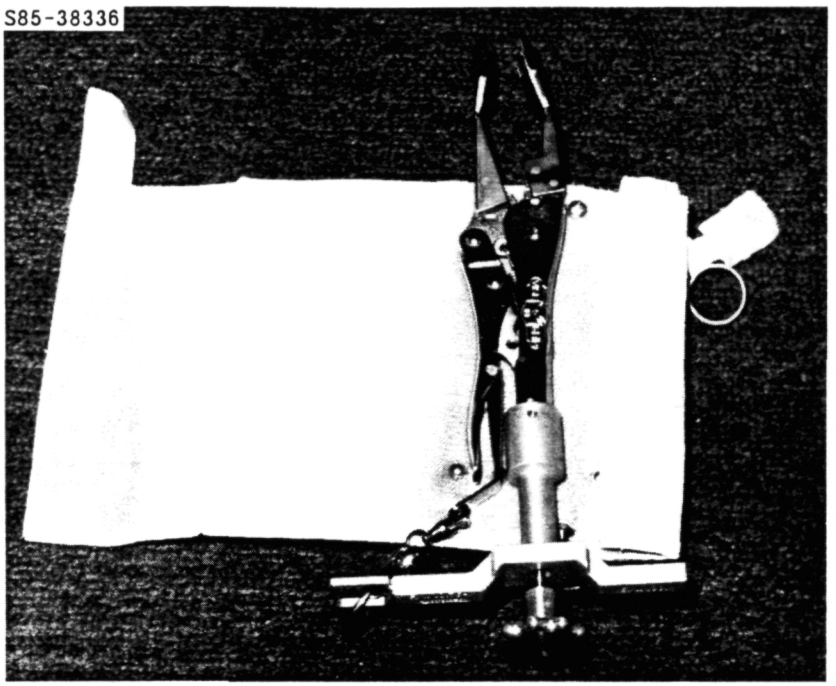
10181-10003-01



10181-10003-03

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

ELECTRICAL CIRCULAR CONNECTOR TOOL



OVERVIEW

The electrical circular connector tool is a 7-inch vise-grip tool modified for removal and installation of circular electrical connectors, flight dustcaps, and flight plugs on satellites.

OPERATIONAL COMMENTS

The electrical circular connector tool requires two hands for proper adjustment but one hand for actual clamping. The extended jaws allow the user to work in deep, close areas where connectors are found. Clamping force is limited to 10 pounds to prevent damage to the electrical connectors. While the jaws are open, they are adjusted over the connector. Once contact is made, the handles are then clamped into the locked position.

This tool was used successfully on STS 51-I, the LEASAT Salvage Mission, to remove flight caps and shorting plugs from connectors on the Syncom F-3 spacecraft.

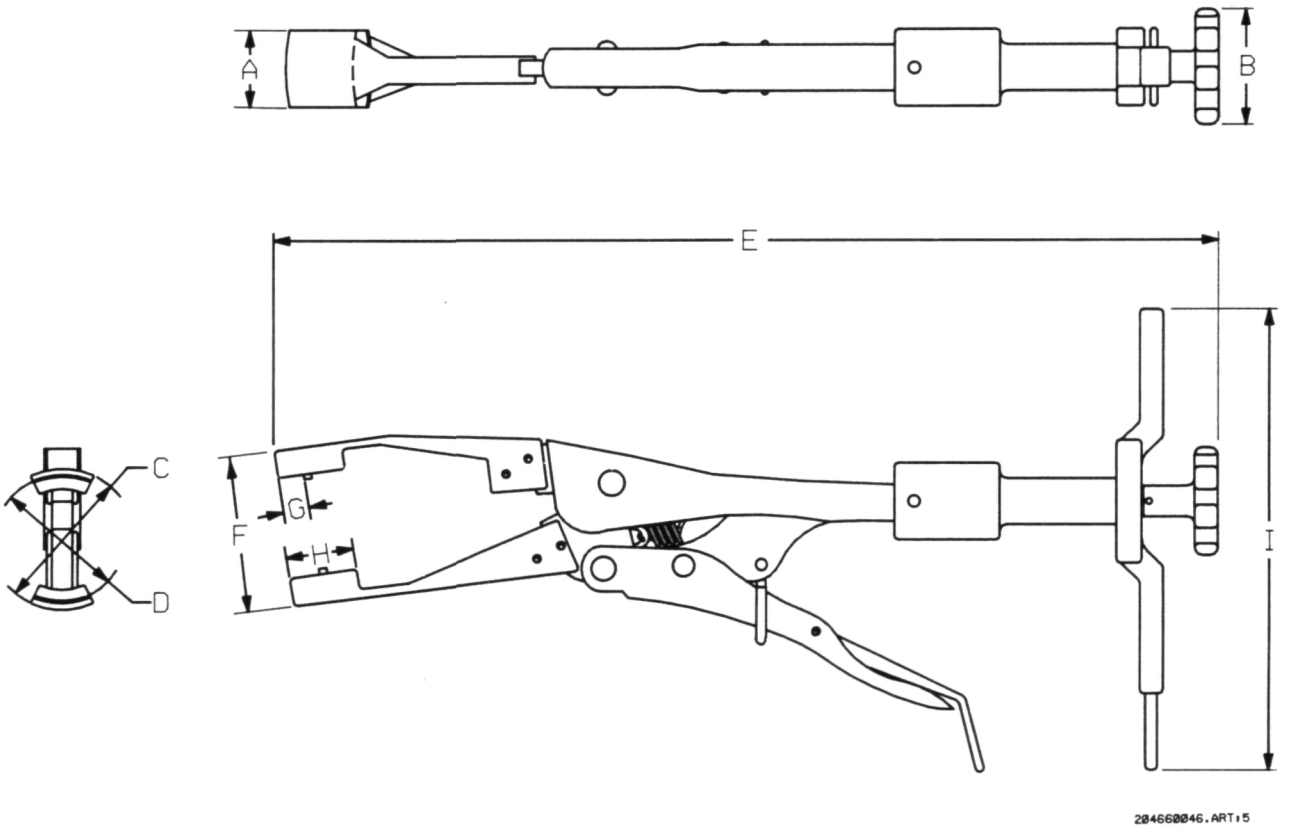
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: C. E. Whitsett, NASA/EC1, (713) 483-9111
Source: M. Withey, ILC Space Systems, (713) 488-9080

ELECTRICAL CIRCULAR CONNECTOR TOOL

Technical Information	
Part number	10176-20100-01
Weight	1.27 lb
Material	Aluminum, stainless steel
Torque limit (clamping)	40 in-lb
Force limit (clamping)	10 lb maximum
Min. connector dia	0.5 in.
Max. connector dia	1.875 in.
Quantity flown	Two on STS 51-I
Stowage	Tool caddy #3 on STS 51-I
Availability	Flight specific

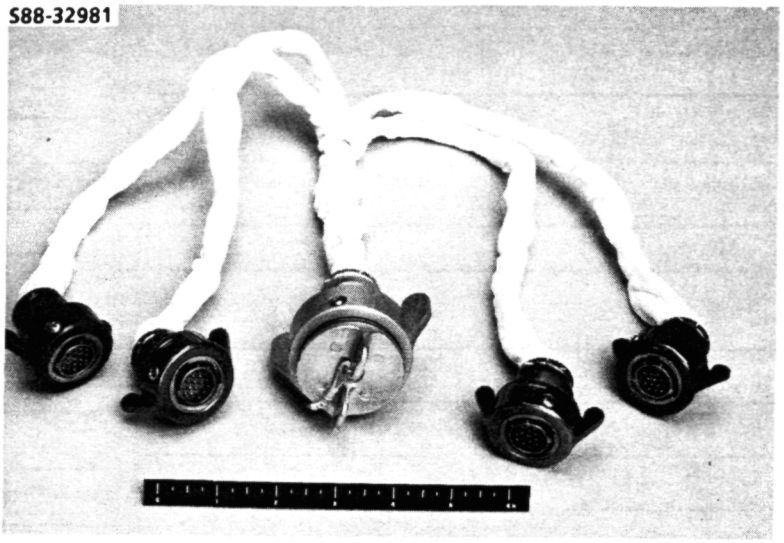
Dimensional Data	
A	1.000 in.
B	1.500 in.
C	2.060 in.
D	1.875 in.
E	12.125 in.
F	2.060 in
G	0.380 in.
H	0.880 in.
I	6.000 in.



204680046.ART;5

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

ELECTRICAL CONNECTOR AND CAP, EVA



OVERVIEW

The EVA electrical connector and cap assembly is an electrical circular connector with added features for EVA protection and function. These features include a high profile adapter wing, integral strain relief, and winged dust cap.

OPERATIONAL COMMENTS

Existing connector configuration is fabricated to specific end-use needs for the EVA power package. However, the assembly piece parts can be designed for qualification to any desired system application.

The adapter wing provides grip ease for suited operation. The adapter enlarges the overall connector diameter to accommodate the limited dexterity of the gloved hand.

The strain relief is a coned piece which screws directly to the connector and protects the electrical connection from direct application of force. The cone provides a receptacle for encapsulation, which seals the cable/connector juncture and directs pull force to the strain relief and cable rather than the electrical connections.

A winged dust cap provides protection to the exposed pins in the connector. The wings allow easy installation and removal by a gloved hand.

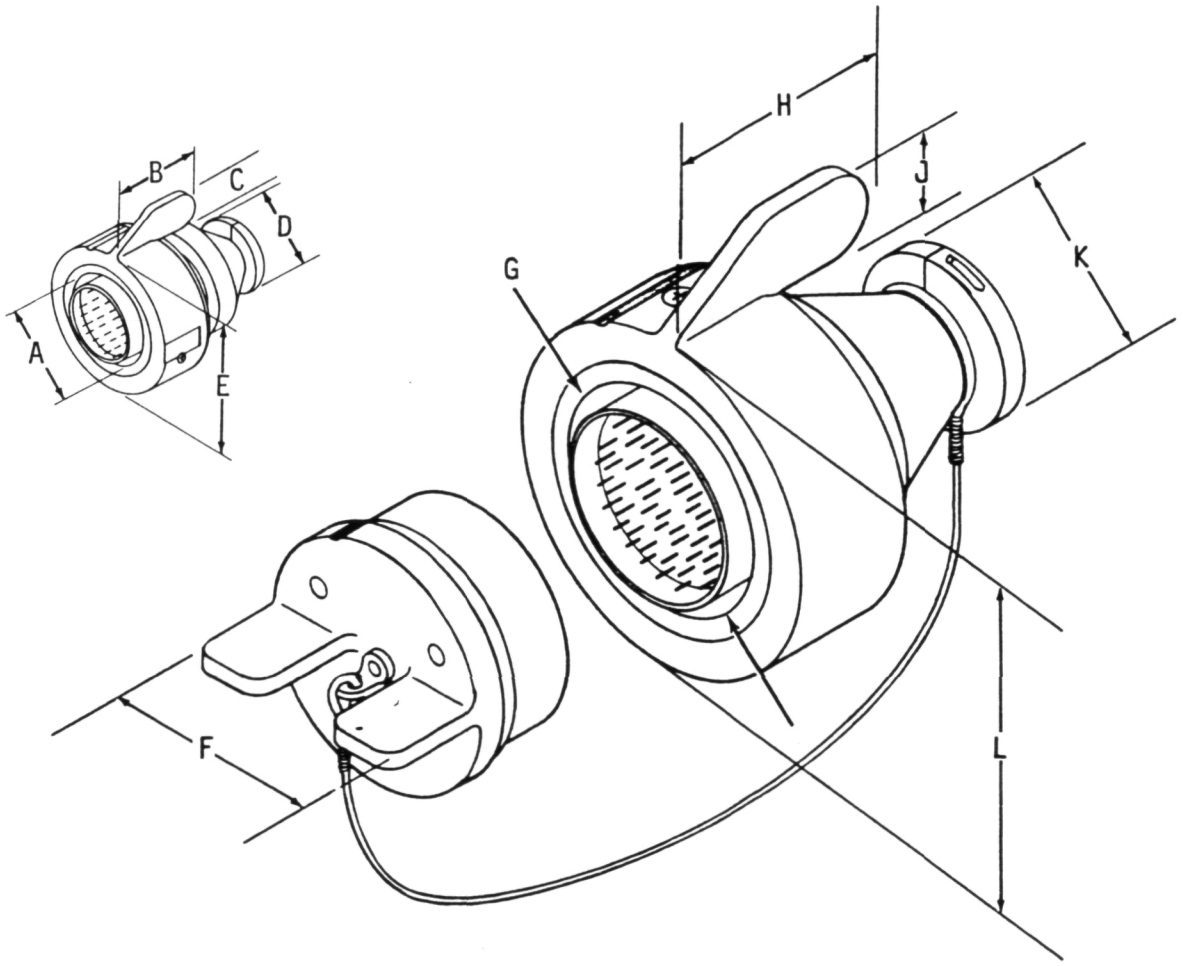
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 483-9080

ELECTRICAL CONNECTOR AND CAP, EVA

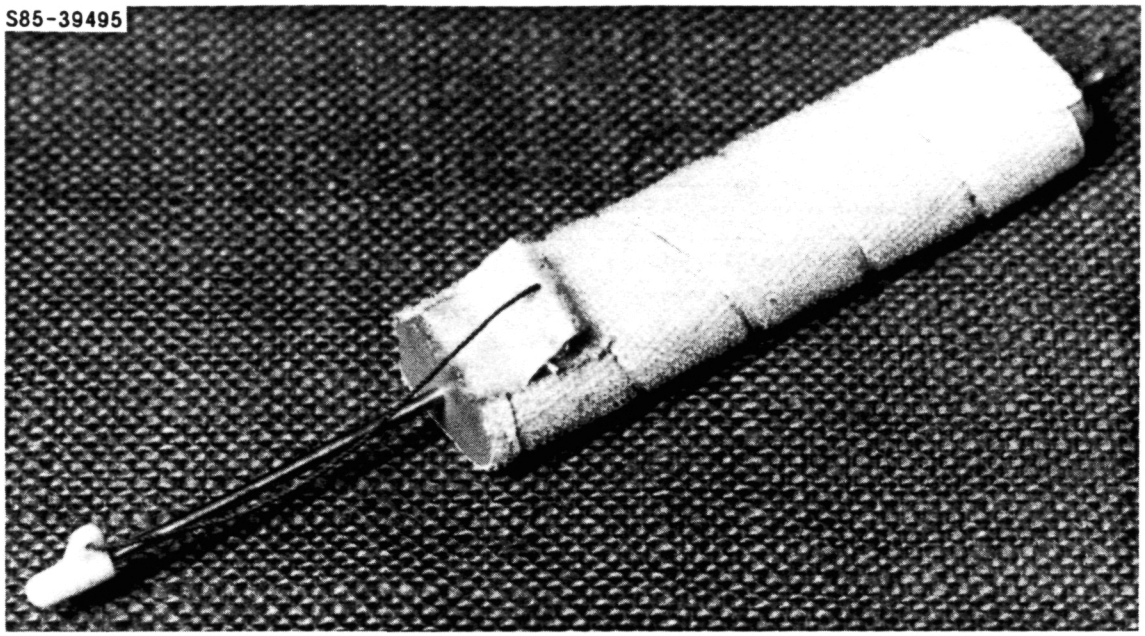
Technical Information	
Part number	10175-20024-01 (large and small connectors) 10175-20031-01 (large dust cap)
Weight	0.40 lb (large connector) 0.20 lb (small connector)
Material/ construction	Aluminum
Temperature range	-130° to +150° F
Dust cap lanyard length	8.0 in.
Availability	Flight specific

Dimensional Data	
A	1.08 in.
B	0.97 in.
C	0.35 in.
D	0.83 in.
E	1.62 in.
F	1.88 in.
G	1.69 in.
H	1.50 in.
J	0.56 in.
K	1.06 in.
L	2.00 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

ELECTRICAL CONNECTOR PIN STRAIGHTENER



OVERVIEW

The electrical connector pin straightener is a simple tool for straightening bent pins in electrical connectors during an EVA. It consists of a small-diameter metal tube with a Velcro-wrapped handle with tether ring attached. A safety guard permanently tethered to the handle covers the tip of the straightener before and after use. It will straighten pins attached to 20-gauge or smaller wires.

OPERATIONAL COMMENTS

The pin straightener tube is open at the tip so that it can be slipped onto the end of a bent electrical connector pin and manipulated until the pin is straight enough to function properly. It can be stowed by itself or in a tool caddy.

This tool has flown on STS 41-C, Solar Maximum repair mission, and STS 51-I, Leasat Salvage Mission, but has never been used on orbit.

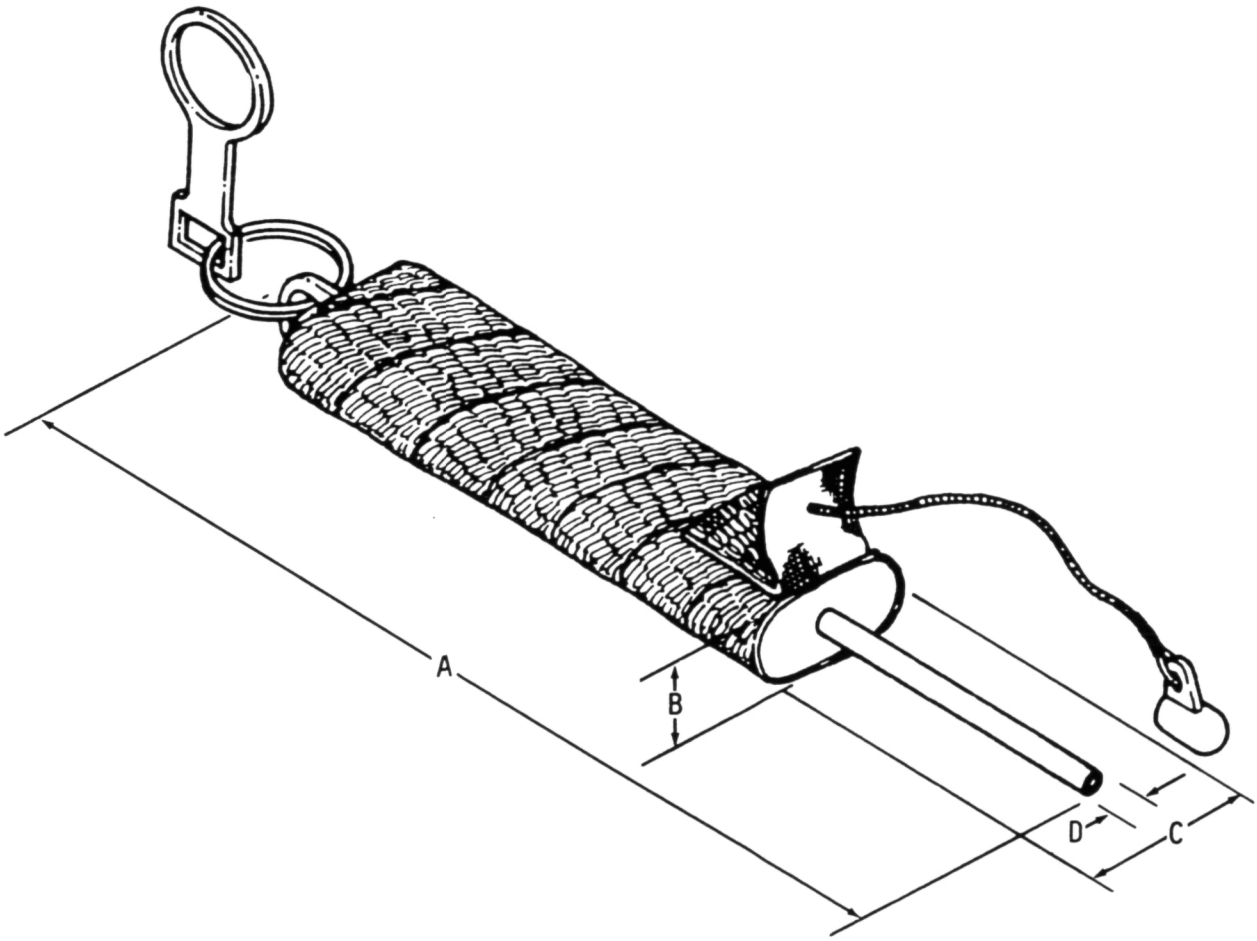
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

ELECTRICAL CONNECTOR PIN STRAIGHTENER

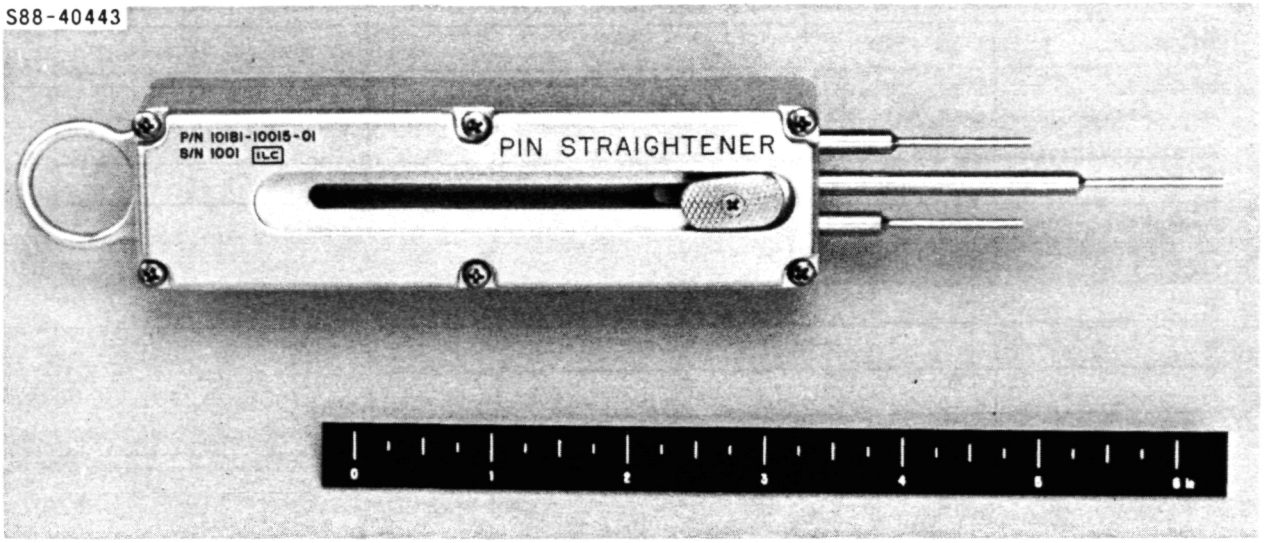
Technical Information	
Part number	10176-20147-01
Weight	0.4 lb
Material	Handle and straightener - aluminum Tip - Teflon
Quantity flown	One on STS 41-C and STS 51-I
Stowage	Transfer bag on STS 51-I
Availability	Flight specific

Dimensional Data	
A	9.340 in.
B	0.750 in.
C	1.375 in.
D	0.042 in.(ID) 0.125 in.(OD)



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

ELECTRICAL CONNECTOR PIN STRAIGHTENER, MULTISIZE



OVERVIEW

The multisize electrical connector pin straightener is a tool for straightening bent pins in electrical connectors on the Hubble Space Telescope (HST). It consists of three metal shafts, two of one diameter and one of a smaller diameter, recessed within an aluminum box. The pins are extended as needed during EVA. There is a tether ring to secure the tool to the worksite or crewmember.

OPERATIONAL COMMENTS

The smaller shaft of the electrical connector pin straightener accommodates 22-gauge pins. The two identical larger shafts accommodate 20-gauge pins. Each shaft works independently of the others. The crewmember can extend any of the shafts by simultaneously depressing and sliding its button forward. The bent connector pin is inserted into the extended shaft of the straightener to the apex of the bend. The crewmember then carefully works the bend out of the pin by applying pressure in the direction opposite from the bend. The shaft lengths may be adjusted as needed to accomplish the straightening process.

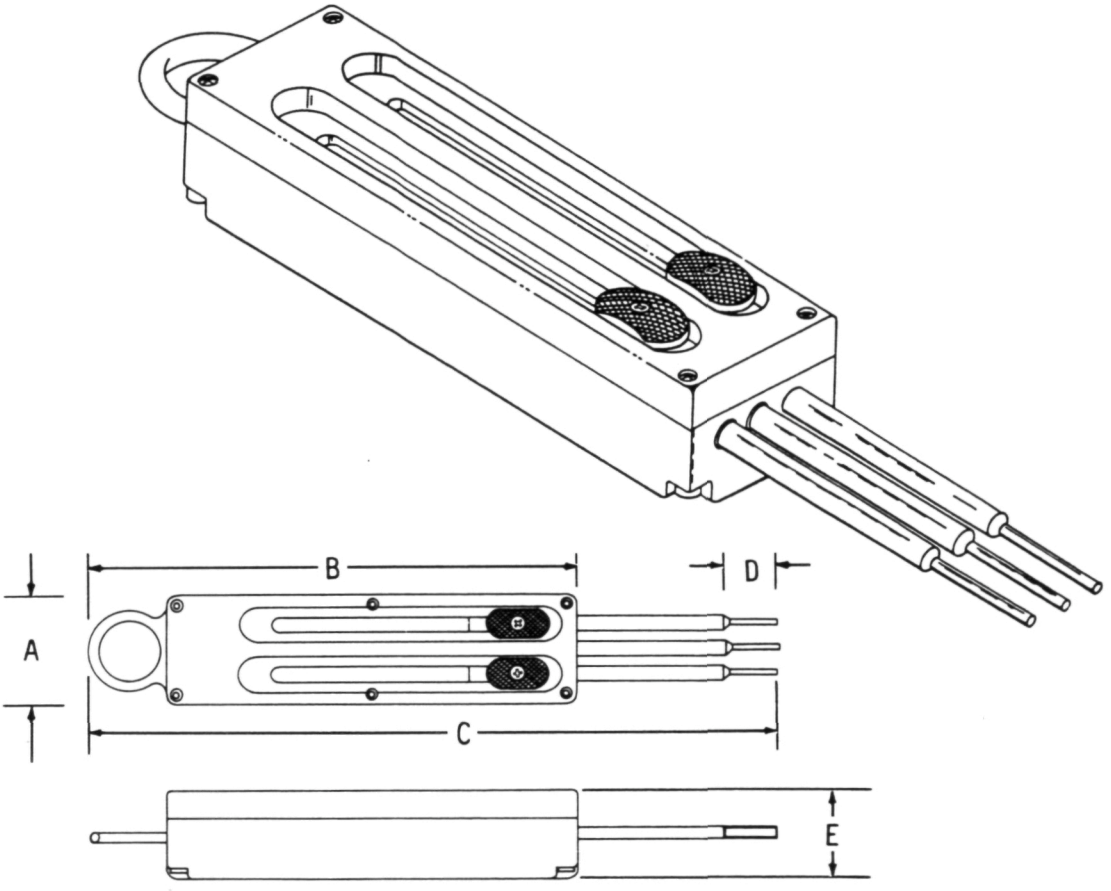
CONTACTS

Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

ELECTRICAL CONNECTOR PIN STRAIGHTENER, MULTISIZE

Technical Information	
Part number	10181-10015-01
Weight	0.60 lb
Material/ construction	Pin slides: stainless steel Housing: aluminum Knobs: knurled aluminum
Temperature range	-150° to +250° F
Straightener characteristics	Depth 0.500 ID 0.042 (outer blades) 0.032 (center blade) OD 0.680
Availability	Flight specific

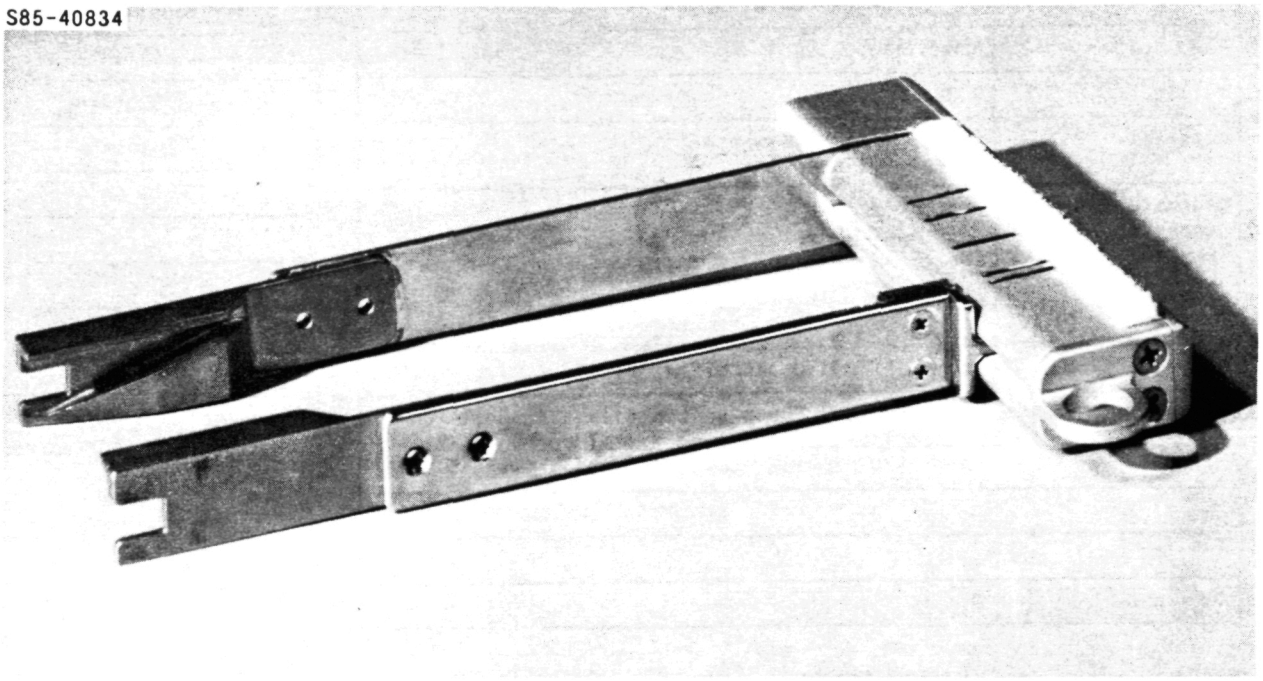
Dimensional Data	
A	1.38 in.
B	5.94 in.
C	8.90 in.
D	1.00 in.
E	1.27 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

ELECTRICAL D-CONNECTOR INSTALLATION TOOL

S85-40834



OVERVIEW

The electrical D-connector installation tool, also known as the electrical connector mating tool, is used for replacement of D-style electrical connectors on satellites.

OPERATIONAL COMMENTS

The electrical D-connector installation tool is suitable for one-handed operation by a suited crewmember. The tool consists of a handle and two prongs which extend from the handle. One of the prongs is movable to five positions laterally along the handle to enable use of the tool for various size connectors. Connector holders are attached at the ends of each prong and are machined to accommodate the trapezoidal shape of the D-connector. The holders are positioned over the connector while the crewmember pushes the connector into place before releasing the holders. A tether ring is integral to the tool handle. Velcro on both sides of the handle provides grips for the crewmembers as well as further attachment points. Tooled marks on the handle define movable prong positions.

The tool was successfully used on the Solar Maximum Repair Mission (SMRM).

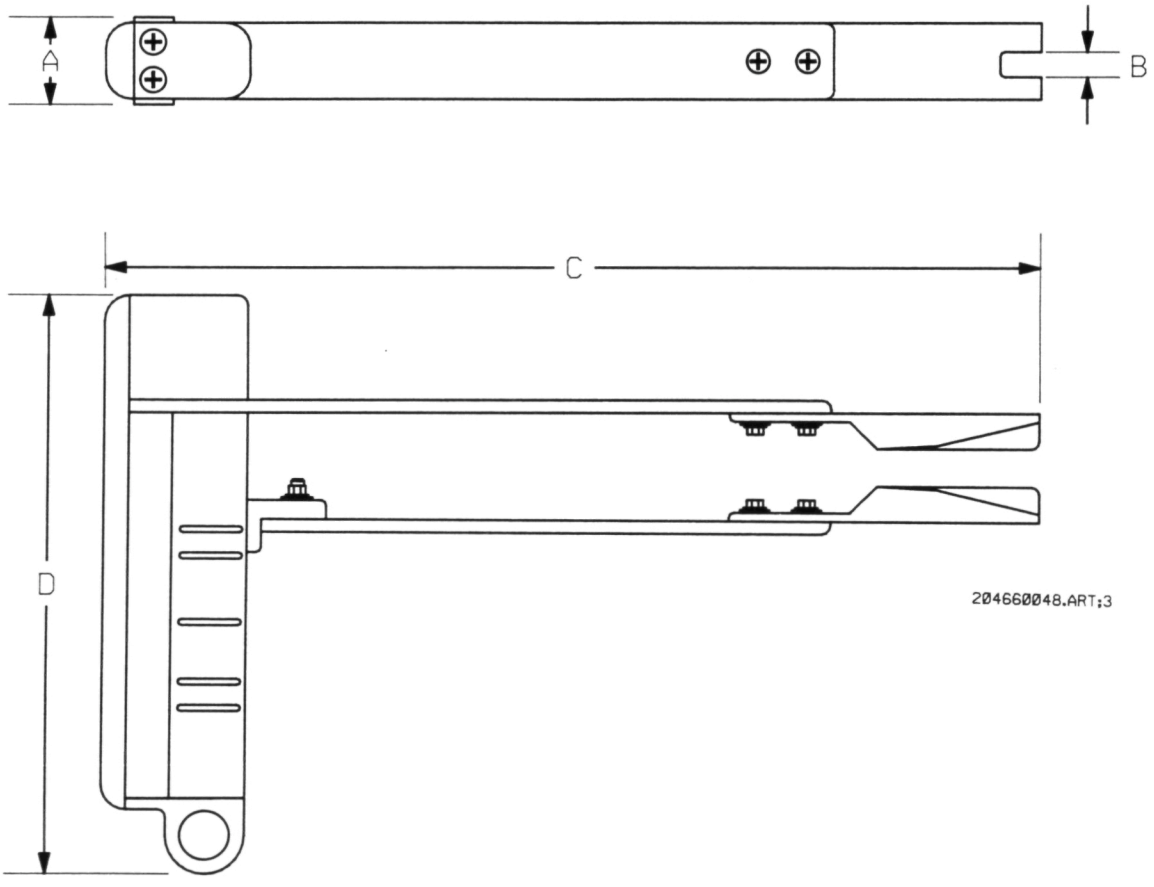
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

ELECTRICAL D-CONNECTOR INSTALLATION TOOL

Technical Information	
Part number	SED33102630-303
Weight	0.98 lb
Material	Prongs - stainless steel Handle - aluminum
Distance between connector holders (at widest point)	Position 1 5.6 cm 2 5.3 cm 3 4.0 cm 4 2.7 cm 5 1.8 cm
Quantity flown	One on STS 41-C and STS 41-B
Stowage	One on a tool board in the flight support system locker and one on a tool board in the special equipment stowage assembly for STS 41-B
Availability	Flight specific

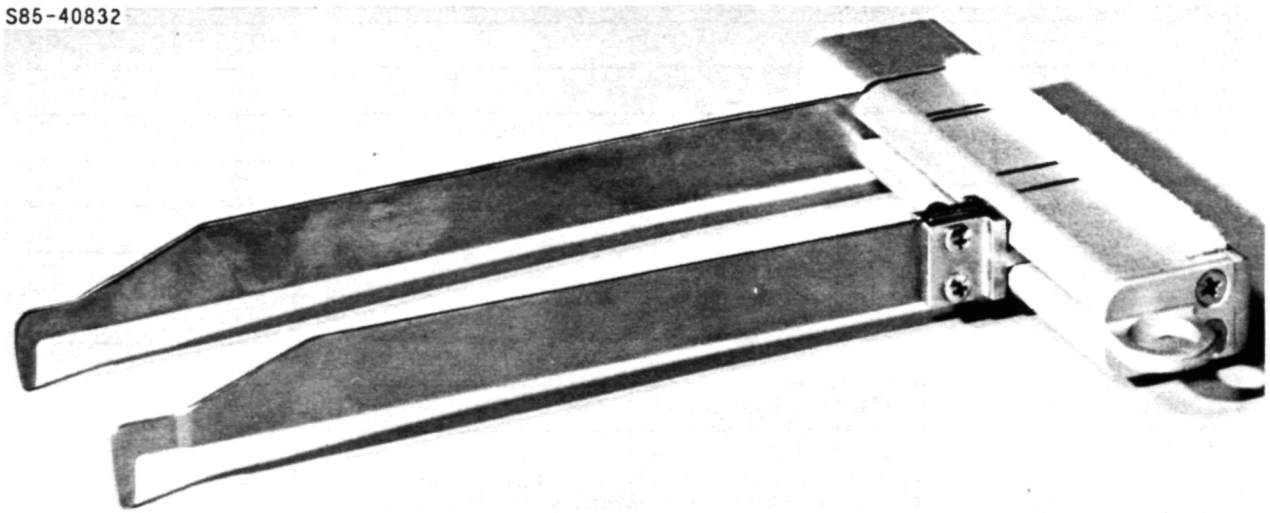
Dimensional Data	
A	0.85 in.
B	0.25 in.
C	8.00 in.
D	5.70 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

ELECTRICAL D-CONNECTOR REMOVAL TOOL

S85-40832



OVERVIEW

The electrical D-connector removal tool is used for removal of D-style electrical connectors on satellites.

OPERATIONAL COMMENTS

The electrical D-connector removal tool is suitable for one-handed operation by a suited crewmember. The tool consists of a handle and two prongs with hooked ends which extend from the handle. One of the prongs can be moved along a slide in the handle to four positions. The ends of each prong form an L-shaped hook 9 mm deep. These hooks are positioned under the connector flange in order to pry the connector loose when the handle is pulled down. A tether ring is integral to the tool handle. Velcro strips on each side of the handle provide gripping power for the crewmember. Tooled marks on the handle define the positions for the movable prong.

The tool was successfully used during the repair of the Solar Maximum Satellite (STS 41-C).

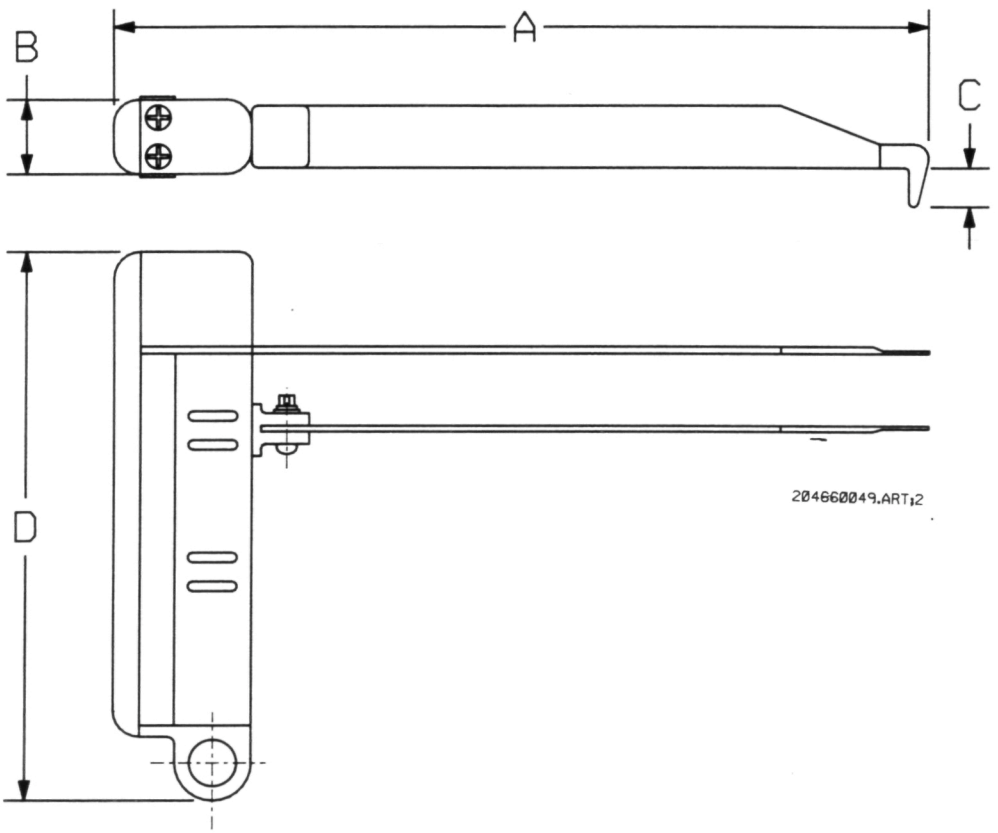
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

ELECTRICAL D-CONNECTOR REMOVAL TOOL

Technical Information	
Part number	SED33102623-303
Weight	0.71 lb
Material	Prongs - stainless steel Handle - aluminum
Distance between prong hooks	Position 1 5.2 cm 2 4.9 cm 3 1.6 cm 4 1.3 cm
Hook depth	9 mm
Quantity flown	One on STS 41-B and STS 41-C
Stowage	One on a tool board in the flight support system locker and one on a tool board in the special equipment stowage assembly for STS 41-C
Availability	Flight specific

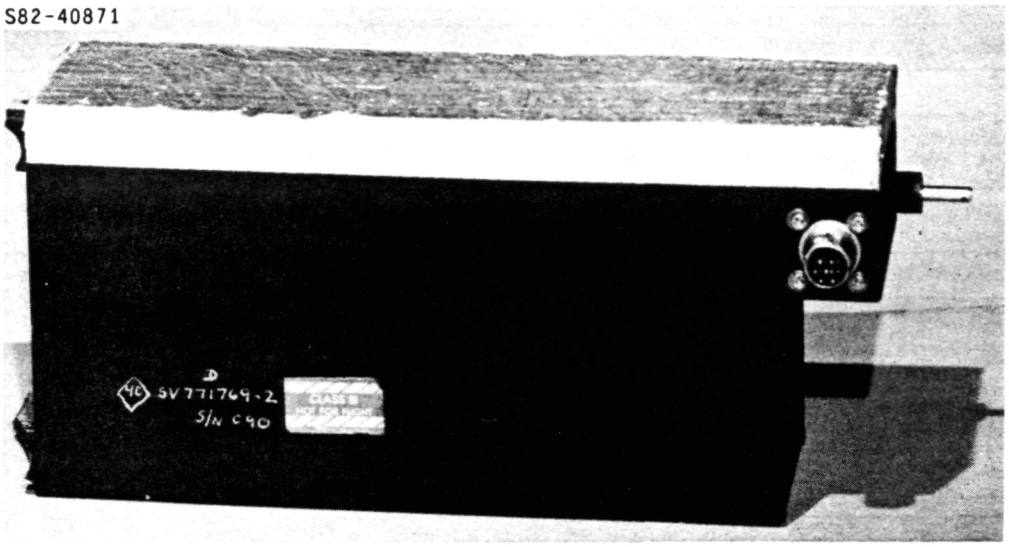
Dimensional Data	
A	8.375 in.
B	0.850 in.
C	0.350 in.
D	5.700 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

EMU BATTERY

S82-40871



OVERVIEW

The extravehicular mobility unit (EMU) battery is the power supply for all the electrical and electronic components of the EMU.

The battery consists of 11 silver-zinc cells connected in series. Each cell has two relief valves in series. This arrangement forms a sealed system for safety in case of excess pressure. An absorbent material is placed in the cavity behind each relief valve to keep the KOH electrolyte from leaking out of the battery when the relief valves are open. Teflon and aluminum tape cover the battery cell cavity.

OPERATIONAL COMMENTS

The EMU battery is stored dry before launch and is activated on the ground by filling with premeasured electrolyte. In flight, prior to EVA, the battery can be replaced by a spare or recharged while in the primary life support subsystem. The battery is certified for 26.6 amp-hours after eight recharge cycles and has a 135-day shelf life after activation. Generic missions carry one battery installed in each EMU and one spare stowed in a middeck locker. Scheduled EVA missions carry a total of two spare EMU batteries.

The EMU battery is also used to power the EVA power package (EPP) and the module servicing tool (MST).

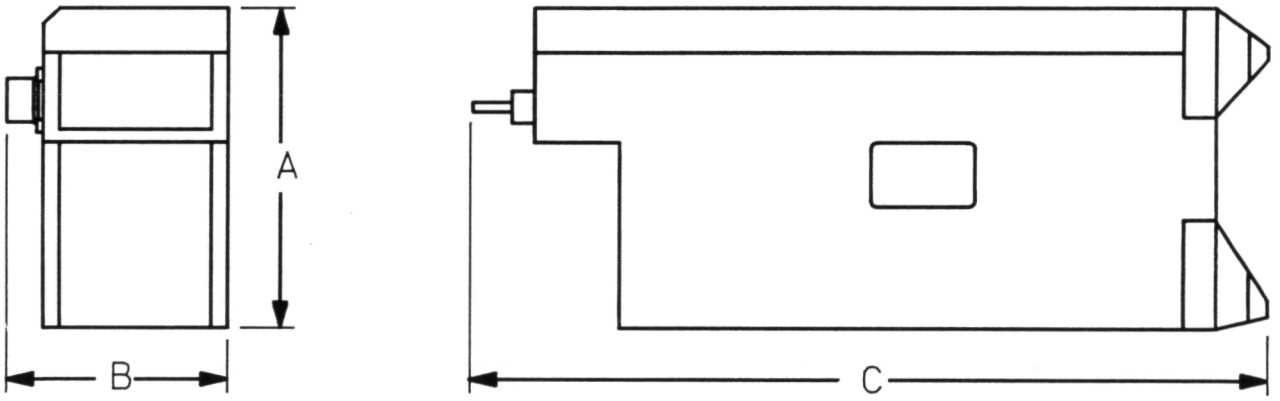
CONTACTS

Operational: C. H. Armstrong, NASA/DF42, (713) 483-2588
Technical: W. Burton, NASA/EC6, (713) 483-9251
Source: B. J. Bragg, NASA/EP5, (713) 483-9040

EMU BATTERY

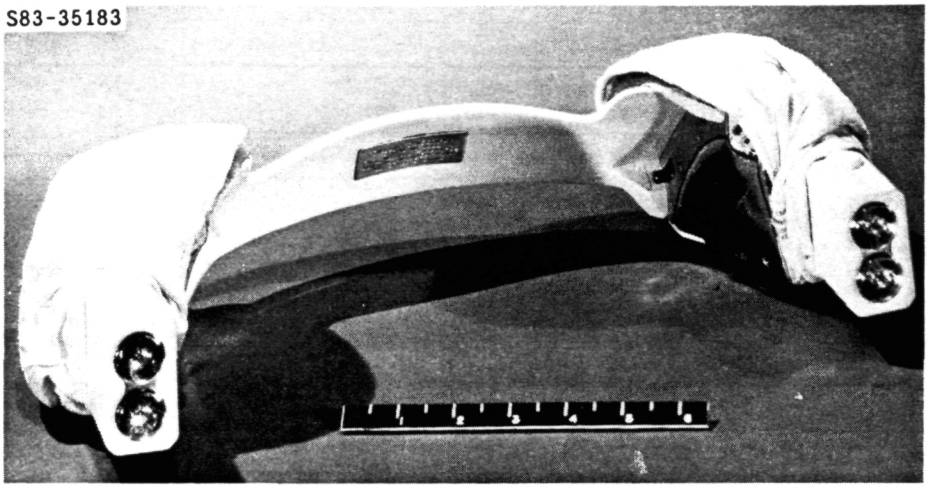
Technical Information	
Part number	SED13101547-301
Weight	9.6 lb
Voltage	16.2 to 17.0 V dc (loaded) 20.5 V dc (no load)
Power	26.6 A-hr (minimum after 8 recharge cycles) 30.0 A-hr (new)
Current	3.5 A (nominal)
Full-recharge time	20 hr
Shelf life	135 days (after charging with electrolyte)
Availability	Standard

Dimensional Data	
A	5.00 in.
B	3.35 in.
C	12.25 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

EMU LIGHTS



OVERVIEW

The extravehicular mobility unit (EMU) lights assembly provides a crewmember with portable lighting during an EVA task. The assembly contains two independent lamp modules connected by a cross member. Each side contains a battery module, two lamps, a switch, a sequencing circuit (powered by four small watch-sized batteries) and a thermostatic cutoff switch. The battery module can supply power to illuminate one lamp for 6 hours, with less than 10 percent degradation of light intensity. The EMU lights attach to the helmet with simple latches, and receptacles for the EMU TV are also provided.

OPERATIONAL COMMENTS

On the EMU lights, each lamp module has a left-right swing angle of 85° (5° towards the helmet and 80° away from the helmet) and an up-down swing angle of 60° (30° up and 30° down). The switch provides one-hand operation of the lamp module. Repeatedly depressing the switch sequences the upper lamp on, the lower lamp on, both lamps on, both lamps off. Because of battery thermal constraints dual lamp operation is discouraged. The lights are useful in providing illumination during the 45 minutes of darkness of each orbit.

The lights are launched with a plastic plug in place of the battery module to prevent inadvertent depletion of the sequencer circuit batteries. The lights must be removed from the helmet for entry due to the lack of crash load certification. Modifications in the near future will replace the electronic sequencing circuitry with switch actuated mechanical sequencing. Dual bulb operation will also be eliminated.

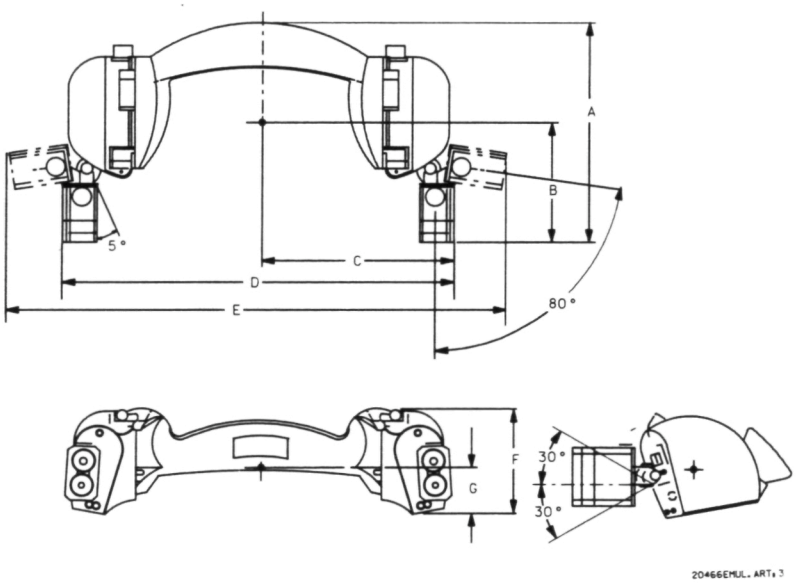
CONTACTS

Operational: C. H. Armstrong, NASA/DF42, (713) 483-2588
Technical: W. B. Wood, NASA/EC6, (713)483-9247
Source: M. Withey, ILC Space Systems, (713) 488-9080

EMU LIGHTS

Technical Information	
Part number	10161-10061-04
Weight	5.00 lb (without main batteries) 5.88 lb (with main batteries)
Main power supply	Two independent battery modules (one per side)
Main batteries	D-size lithium bromine complex (3.5 V, 8 A-h each)
Battery life	6 hr nominal, one lamp per side operating
Voltage Open circuit Loaded	 3.77 ± 0.2 V dc 3.25 V dc
Lamps	Two halogen lamps per side (2.5 W each)
Lamp intensity	20 ft-c (min.) per lamp at 3 ft
Lamp life	20 hr
Lighting pattern	16 by 24 in. at 2 ft (four lamps on pointed forward)
Operation	Push button switch activated sequencing circuit on each side
Sequencer power supply	Four watch batteries in series per side
Sequencer battery	Silver oxide, 1.5 V Duracell, 38 mA-hr
Thermal protection	160° ± 5° F thermal cutoff switch and multilayer insulation
Structural F.S.	1.4
Quantity flown	Two in the middeck Volume H locker
Availability	Standard

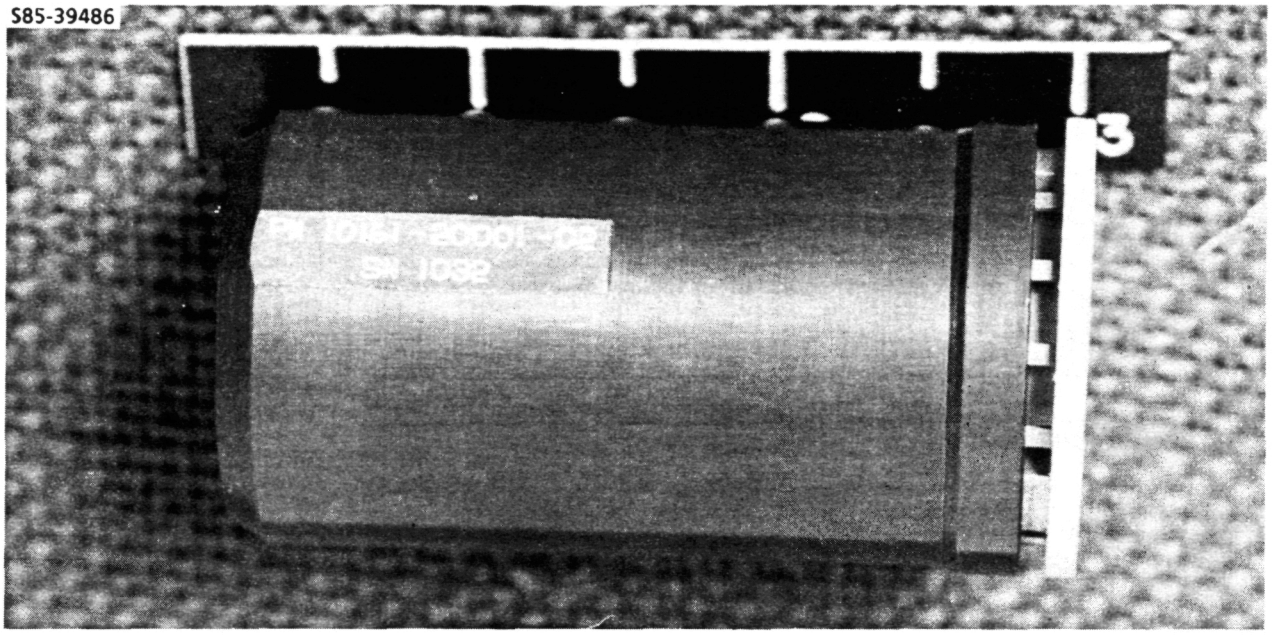
Dimensional Data	
A	8.81 in.
B	4.66 in.
C	7.76 in.
D	15.52 in
E	19.78 in.
F	4.30 in.
G	1.88 in.



20466EMUL.ART.3

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

EMU LIGHTS BATTERY



OVERVIEW

The extravehicular mobility unit (EMU) lights batteries are required to supply the power for the EMU lights (one per side).

OPERATIONAL COMMENTS

Each EMU lights battery provides 2.5 watts to power one bulb on one side for 6 hours (0.7 amps at 3.6 +0.2/-0.5 load volts dc). A built-in fuse protects against inadvertent shorting of the contacts. There is a danger of the batteries venting due to overheating if used in a hot environment.

Twelve EMU lights batteries are stored in the Orbiter Volume H storage locker for each flight. Each battery is replaced prior to each EVA.

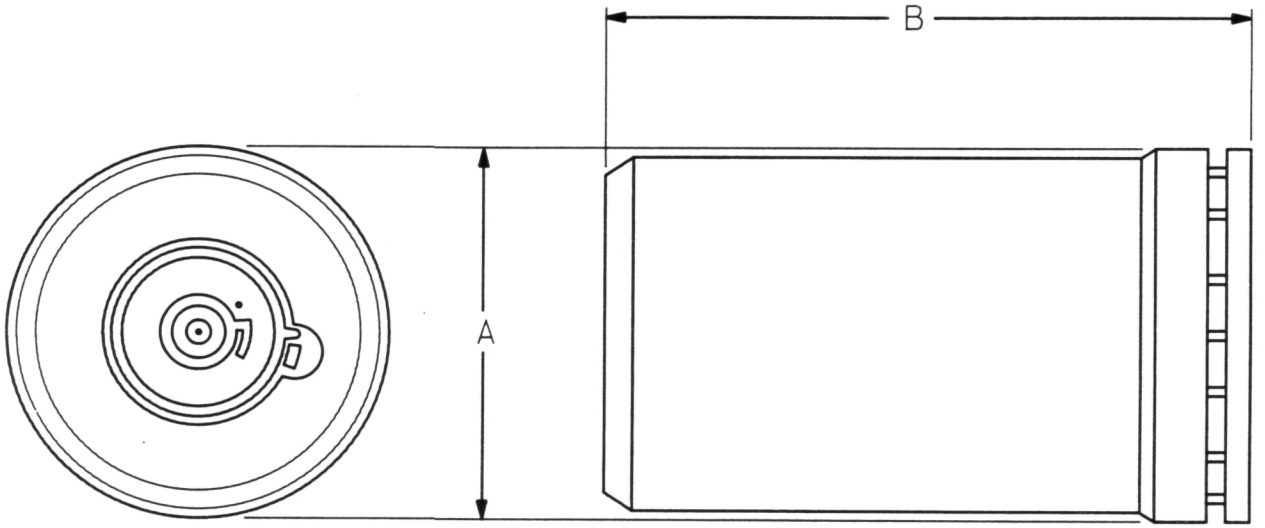
CONTACTS

Operational: C. H. Armstrong, NASA/DF42, (713) 483-2588
Technical: B. J. Bragg, NASA/EP5, (713) 483-9040
Source: M. Withey, ILC Space Systems, (713) 488-9080

EMU LIGHTS BATTERY

Technical Information	
Part number	10161-20001-02
Weight	0.34 lb
Material	Aluminum housing
Battery type	Lithium bromine complex (3.5 V dc)
Temperature range	32° to 160° F (operational)
Volts	3.77 ± 2 V dc (open circuit) 3.25 V dc (loaded)
Shelf life	12 months
Amp-hours	8 A-h
Watts	5.0 W with 2 bulbs for 3 hr (each side) 2.5 W with 1 bulb for 6 hr (each side)
Stowage	Middeck
Quantity flown	Twelve in middeck Volume H locker
Availability	Standard

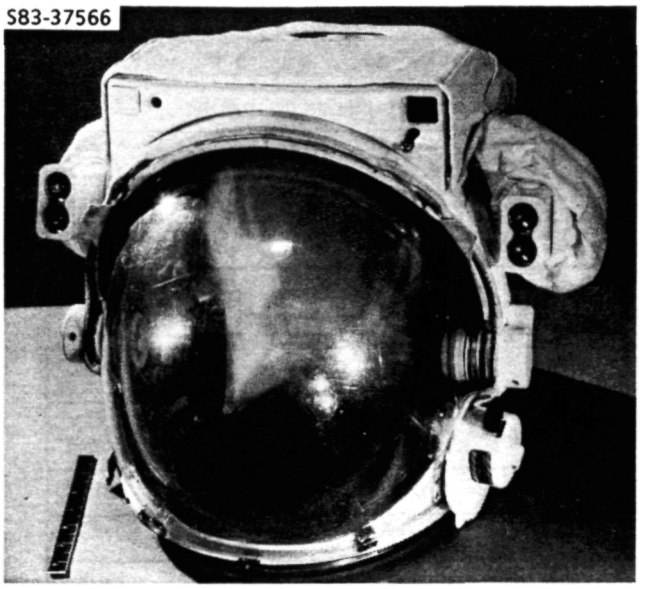
Dimensional Data	
A	1.50 in.
B	2.80 in.



204660052.ART, 2

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

EMU TV



OVERVIEW

The extravehicular mobility unit (EMU) TV is a helmet-mounted, solid-state, color TV camera that provides real-time scenes from the approximate point of view of the crewmember. The EMU TV is comprised of a small TV camera, closeup lens, battery pack, on-off switch, radio frequency (RF) antenna, and an S-band transmitter. The battery pack of eight cells is removable and can supply power for about 6 hours. The Orbiter receives the RF TV transmission through its S-band hemi-antennas and relays the signals to the closed circuit television system for display, recording, or transmission to the ground.

OPERATIONAL COMMENTS

The EMU TV power on/off pushbutton switch is located on the forward right-hand side of the housing. A green light-emitting diode indicator is located to the right of the on/off pushbutton. The normal EMU TV lens provides for viewing objects 36 inches to 25 feet away. The closeup lens allows for viewing objects 12 inches to 36 inches away. The lens is mounted on a movable bracket and can be moved into place using a hand-operated switch located on the forward left side, just below the TV lens opening. The camera field-of-view is 7° below the horizontal. The TV mounts to the EMU helmet by attachment receptacles on the EMU lights.

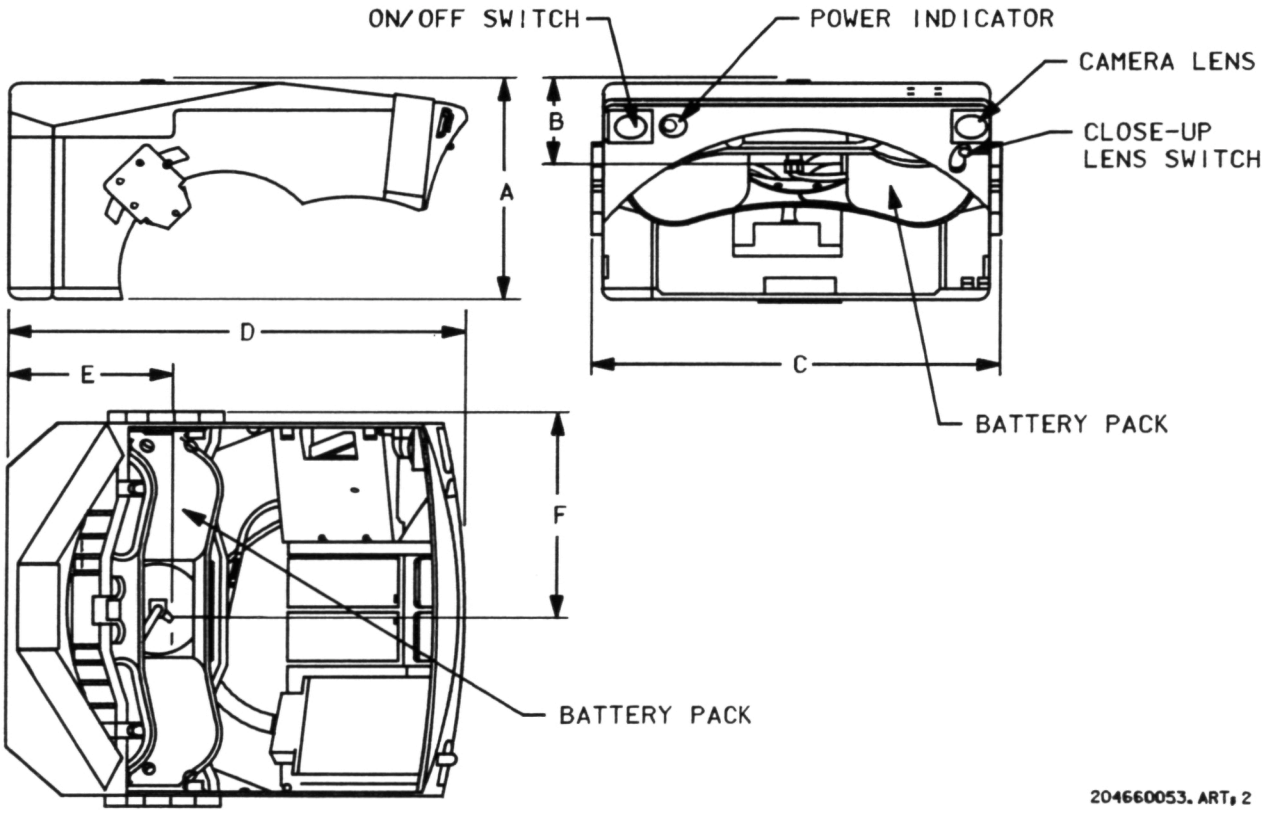
CONTACTS

Operational: C. H. Armstrong, NASA/DF42, (713) 483-2588
Technical: B. C. Embrey, Jr., NASA/EE26, (713) 483-0184
Source: M. Withey, ILC Space Systems, (713) 488-9080

EMU TV

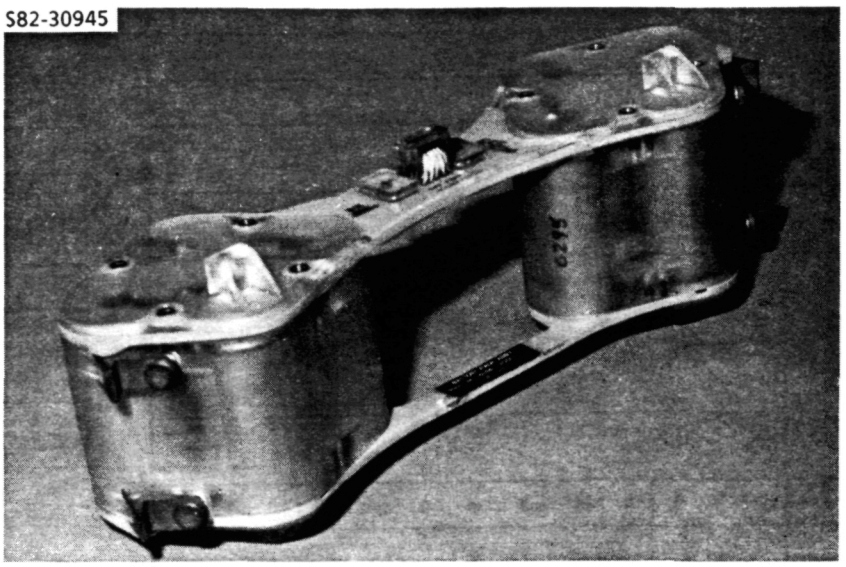
Technical Information	
Part number	SED18100247-304
Weight	11.0 lb (with battery)
Field of view	32° horizontal scan, 25° vertical scan
Normal viewing	36 in. to 25 ft
Closeup viewing	12 in. to 36 in.
TV transmission range	250 ft
Transmission signal	1775.7 MHz at 0.5 watt
Battery duration	6 hr
Quantity flown	One in a middeck locker
Availability	Flight specific

Dimensional Data	
A	6.02 in.
B	2.38 in.
C	10.77 in.
D	12.09 in.
E	4.20 in.
F	5.60 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

EMU TV BATTERY



OVERVIEW

The extravehicular mobility unit (EMU) TV battery provides the power required to run the EMU TV assembly. The battery pack is made up of eight nonrechargeable lithium bromine complex battery cells grouped in two clusters of four. The entire battery pack assembly is easily separated from the TV assembly for replacement.

OPERATIONAL COMMENTS

The EMU TV battery generates a total of 28 volts dc for the main TV circuit. There is also a separate in-line tap to direct 14 volts dc to the logic circuit of the TV power control module. Each cell has a load voltage of approximately 3.5 volts dc at a discharge rate of 0.9 amp for a minimum of 6 hours.

The EMU TV battery is designed to operate at 32° to 160° F, a range well beyond normal expected EVA temperatures inside the well-insulated TV enclosure. Each battery is protected by an internal thermostat that opens the circuit if 160° F is exceeded.

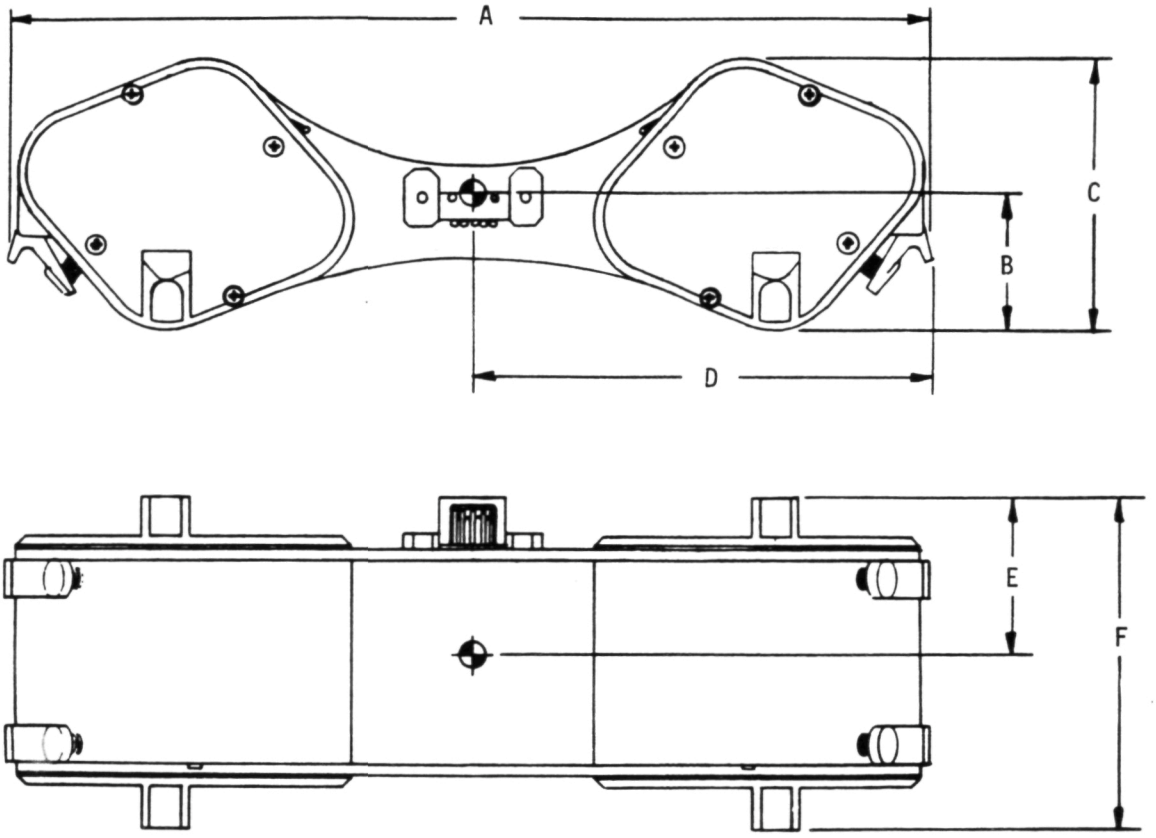
CONTACTS

Operational: C. H. Armstrong, NASA/DF42, (713) 483-2588
Technical: B. J. Bragg, NASA/EP5, (713) 483-9040
Source: M. Withey, ILC Space Systems, (713) 488-9080

EMU TV BATTERY

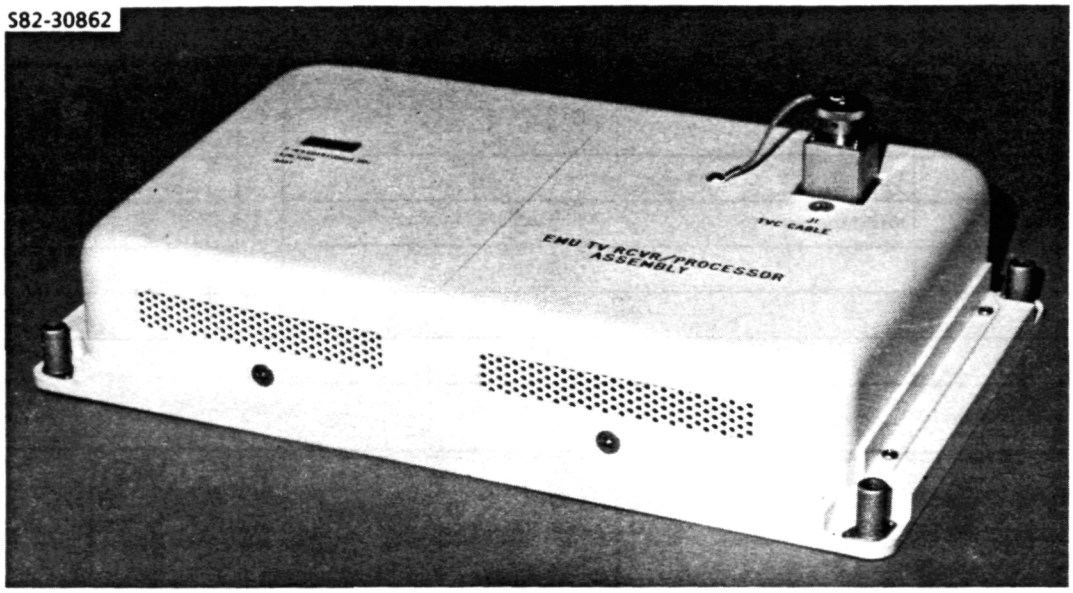
Technical Information	
Part number	10160-20001-02
Weight	2.6 lb
Battery pack voltage	28 V dc
In-line tap voltage	14 V dc
Load voltage per cell	3.5 V dc
Battery pack life rating under continuous use	Minimum 6 hr at 0.9 A discharge rate
Operating temperature	32° to 160° F
Battery type	3.5 V, 8 A-h lithium bromine complex cells
Availability	Flight specific

Dimensional Data	
A	9.93 in.
B	1.48 in.
C	2.97 in.
D	5.21 in.
E	1.80 in.
F	3.59 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

EMU TV RECEIVER AND VIDEO PROCESSOR ASSEMBLY



OVERVIEW

The extravehicular mobility unit (EMU) TV receiver and video processor assembly, also called the radio frequency (RF) receiver/video processing unit (VPU), receives video signals from the EMU TV camera and transmitter and conditions the signals for presentation to the closed circuit television (CCTV) system.

OPERATIONAL COMMENTS

The EMU TV receiver and video processor assembly is mounted in the middeck of the Orbiter and is connected preflight to the S-band antenna switch in the Orbiter. Before use in flight, the crew must connect the EMU TV receiver and video processor assembly to the TV input station with a prestowed CCTV cable, which also carries the TV picture to the CCTV system. The video processor assembly provides dc/dc conversion and furnishes power to the RF receiver. It receives 28 volts dc from the CCTV input station.

The video processor assembly provides dc restoration of the video signal. It also provides a balanced differential output for the CCTV system.

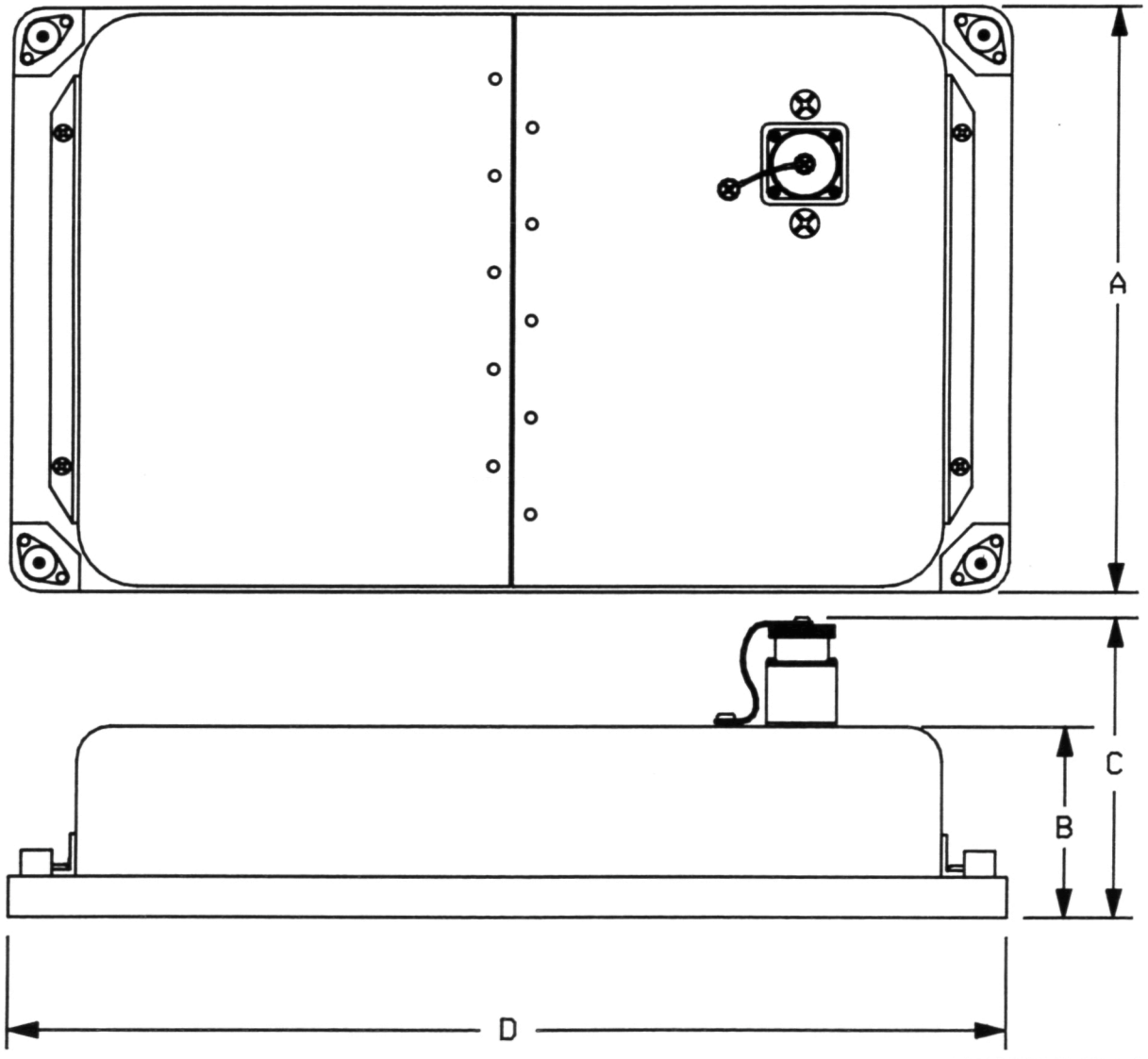
CONTACTS

Operational: C. H. Armstrong, NASA/DF42, (713) 483-2588
Technical: B. C. Embrey, Jr., NASA/EE26, (713) 483-0184
Source: B. C. Embrey, Jr., NASA/EE26, (713) 483-0184

EMU TV RECEIVER AND VIDEO PROCESSOR ASSEMBLY

Technical Information	
Part number	SED18100025-302
Weight	19.4 lb
Power requirement	28 V dc
Power source	CCTV input station
Stowage	Middeck
Availability	Flight specific

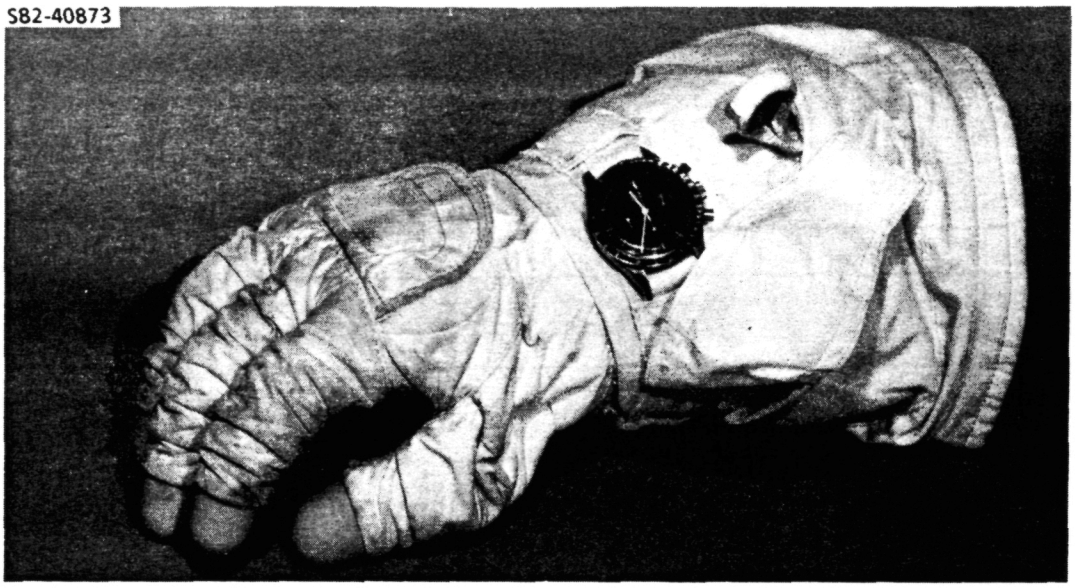
Dimensional Data	
A	10.755 in.
B	3.500 in.
C	5.560 in.
D	18.125 in.



204660055.ART;3

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

EMU WATCH



OVERVIEW

The extravehicular mobility unit (EMU) watch, also called the astronaut chronograph, is an analog, manual-wind watch with a 12-hour movement. It attaches to an integral watchband on the right EMU glove and is covered by a thermal multilayer garment.

OPERATIONAL COMMENTS

The EMU watch attaches to the right EMU glove. This item has been used very sparingly on actual flights and was acquired during the Apollo-era flights.

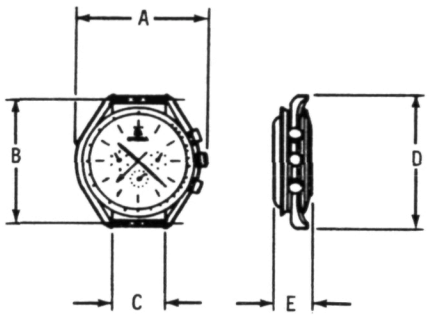
CONTACTS

Operational: C. H. Armstrong, NASA/DF42, (713) 483-2588
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

EMU WATCH

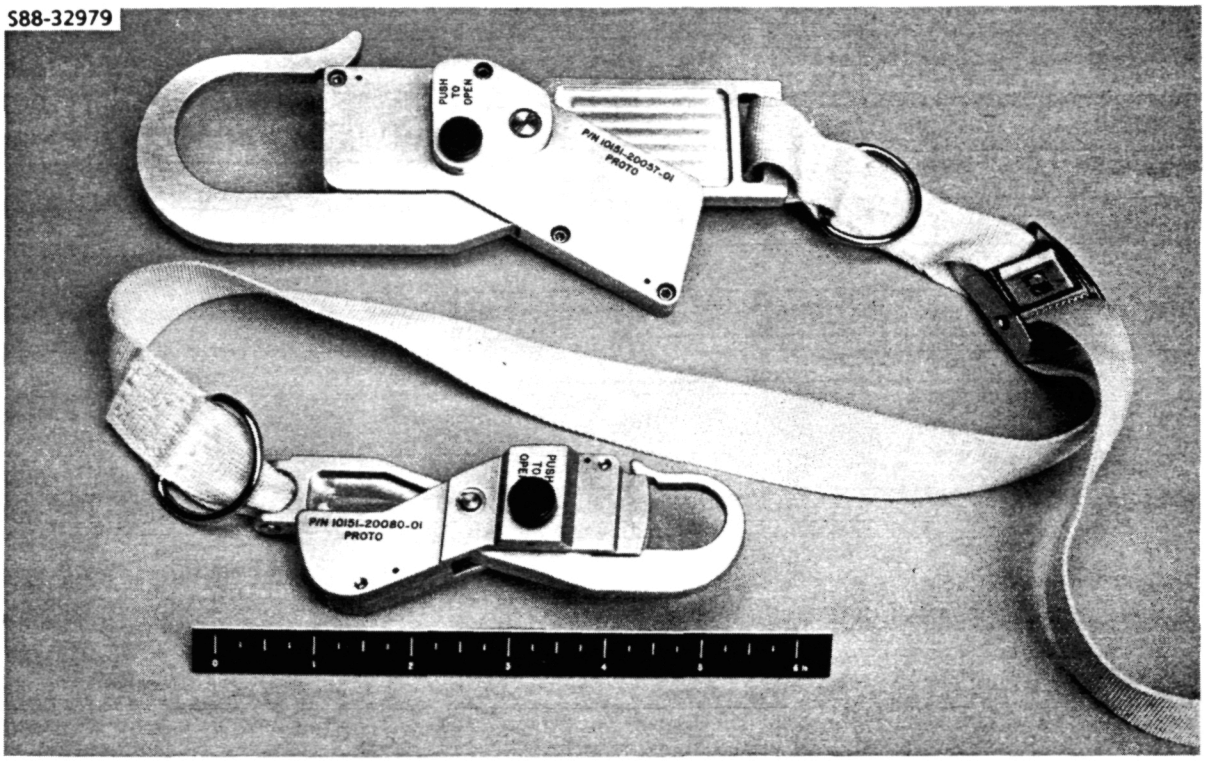
Technical Information	
Part number	SED12100312-301
Weight	0.137 lb
Special material/ construction	Not available
Dial indicator	Hours, minutes, seconds, elapsed time
Manufacturer	Omega
Quantity flown	One for each prime EMU
Availability	Standard

Dimensional Data	
A	1.69 in.
B	1.71 in.
C	0.75 in.
D	1.90 in.
E	0.53 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

EQUIPMENT TETHER, ADJUSTABLE



OVERVIEW

The adjustable equipment tethers are Nomex webbing straps with EVA hooks on either end. The tethers are used by the EVA crewmembers to secure tools and equipment. This tether has been designed for use during Hubble Space Telescope (HST) maintenance.

OPERATIONAL COMMENTS

The tethers have one small universal tether hook on one end and one large universal tether hook on the other. The webbing length can be adjusted by using a cam lock buckle. This buckle can withstand a maximum tether load of 500 pounds.

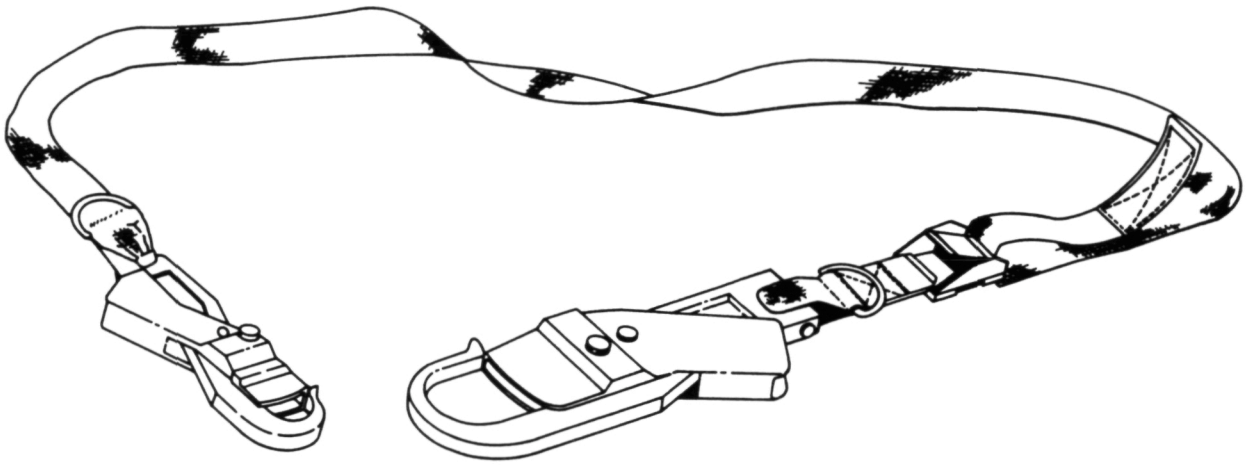
CONTACTS

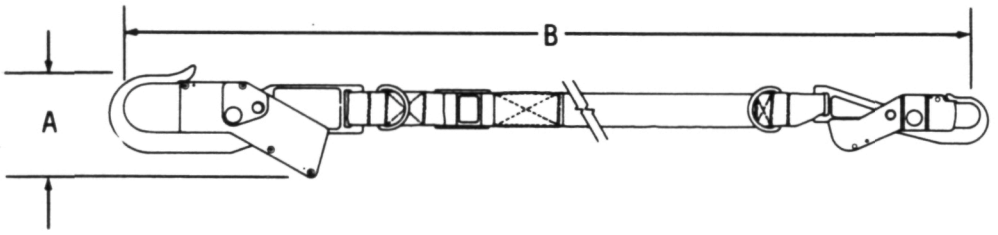
Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

EQUIPMENT TETHER, ADJUSTABLE

Technical Information	
Part number	10181-10016-01 (34-in. tether) 10181-10016-02 (60-in. tether)
Weight	0.78 lb (-01)
Material	Aluminum alloy, Nomex
Buckle strength	500 lb
Availability	Flight specific

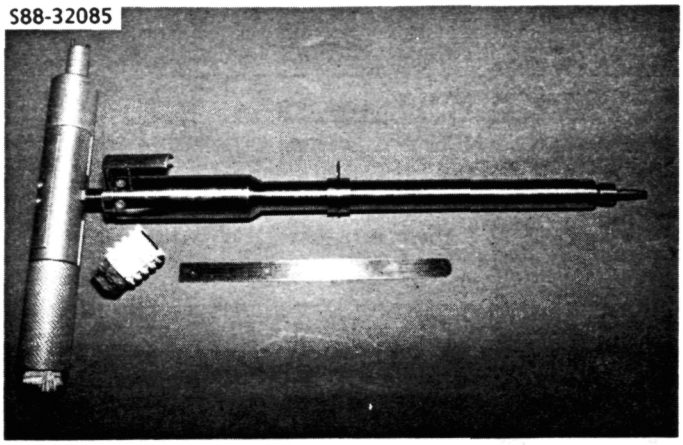
Dimensional Data	
A	4.12 in.
B	18.5 - 34.0 in. (-01) 18.5 - 60.0 in. (-02)





ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

EXTERNAL TANK DOOR LATCH TOOL



OVERVIEW

The external tank door latch tool is used for emergency latch release of the two latches which hold the ET umbilical doors open during launch. The doors must be closed for entry. The ET door latches are normally driven by a motor/clutch system; however, should a failure occur that renders the system inoperable, this manual override is available for releasing the latches.

OPERATIONAL COMMENTS

The external tank door latch tool has a folding tee handle with a spanner wrench on one end. A 1/8-inch hex head drive housed in a threaded barrel assembly interfaces with the Orbiter override clutch mechanism. The barrel assembly also has a latch assembly which is used to control the working depth of the hex head drive shaft.

One thermal tile plug for each latch mechanism is removed using the spanner wrench assembly of the tool handle, exposing the latch drive and clutch mechanism of the door latch override mechanism. The threaded section of the barrel assembly is screwed into the clutch release and an outward force is applied to the barrel section while simultaneously pushing in on the hex head drive shaft latch and the tee handle/hex head shaft to engage the latch mechanism drive unit. When the hex head shaft is engaged, the drive shaft latch may be released, locking the latch override drive and clutch mechanism in operating position. The tee handle is then rotated counterclockwise to release and stow the door latch. Approximately 14 revolutions of the tool are required to release and stow the latch into the Orbiter recess. The tee handle may also be rotated clockwise to drive the mechanism to unstow, extend, and lock the latch open.

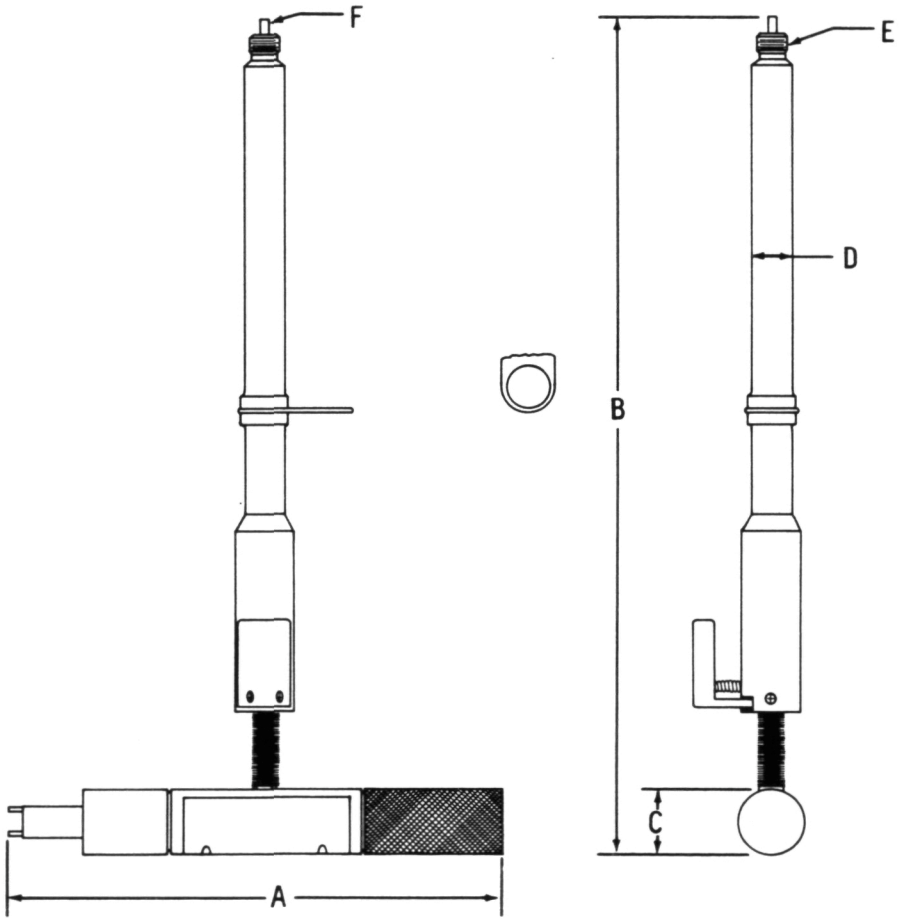
CONTACTS

Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: W. B. Wood, NASA/EC6, (713) 483-9247

EXTERNAL TANK DOOR LATCH TOOL

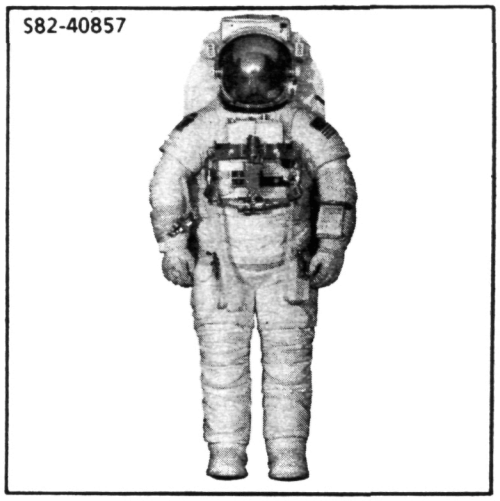
Technical Information	
Part number	SED39118691-301
Weight	2.0 lb (approximate)
Material/ construction	Aluminum Stainless steel Nickel alloy
Temperature range	-130° to +150° F (operational)
Stowage	Port PSA
Quantity flown	One
Availability	Standard

Dimensional Data	
A	8.200 in.
B	14.150 in.
C	1.120 in. dia
D	0.670 in. dia
E	0.500-,200NF-2A
F	0.125 in. hex



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

EXTRAVEHICULAR MOBILITY UNIT



OVERVIEW

The extravehicular mobility unit (EMU) is an independent anthropomorphic system that provides crewmembers with environmental protection, life support, mobility, UHF communications, and visibility while performing various EVA's. The EMU has an on-orbit recharge capability and can provide multiple EVA periods during a single flight.

OPERATIONAL COMMENTS

Two EMU's are included in each Orbiter mission without a scheduled EVA. Three EMU's are flown for a scheduled EVA mission. Consumables can be provided for up to three two-man, 6-hour EVA's, two of which are available for payload use (mission success) and the other reserved for an Orbiter safety-critical EVA. The EMU primary life support system is designed for 7 hours of independent life support, of which only 6 hours are available for nominal EVA's. The EMU also has a backup oxygen system which can provide 30 minutes of open loop purge flow for contingency life support. Instrumentation and a microprocessor provide the capability to monitor the status of the EMU and expendables and to alert the crewmember of any abnormal system function.

Standard interface attachments include the manned maneuvering unit, the mini work station, tool caddies, EMU television system, EMU lights, and the wrist and waist tethers.

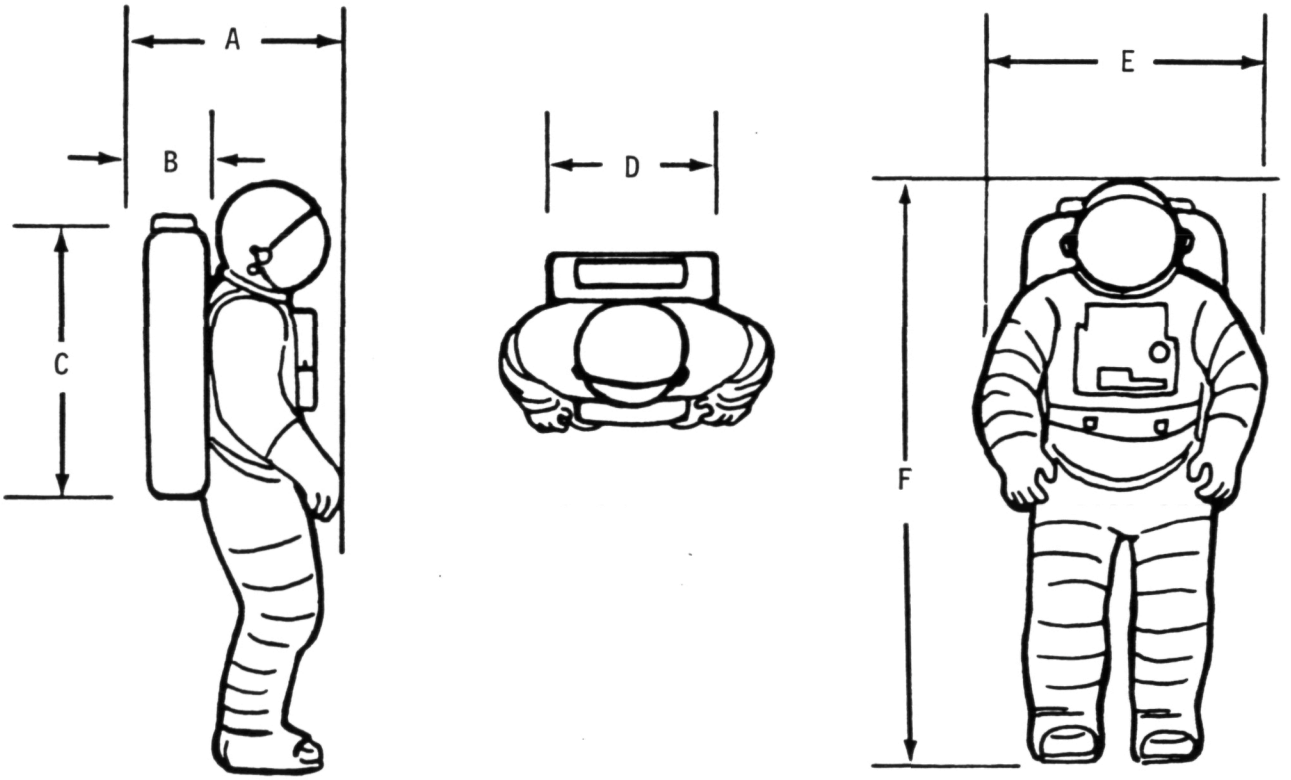
CONTACTS

Operational: C. H. Armstrong, NASA/DF42, (713) 483-2588
Technical: J. W. McBarron, NASA/EC6, (713) 483-9254
Source: Hamilton Standard/ILC Dover

EXTRAVEHICULAR MOBILITY UNIT

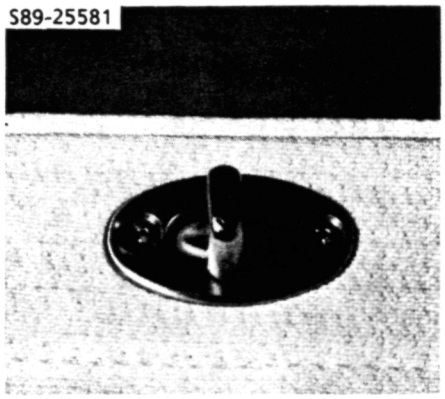
Technical Information	
Part number	SED 13101492-307
Weight	257 lb (min.) 300 lb (max.)
Wrist tether loop breaking force	30 lb
Waist tether D-ring strength	585 lb (static proof load)
Glove contact temperature	-180° to +235° F (1.0 psi pressure for 30 sec)
Availability	Standard

Dimensional Data		
	95% Male	5% Female
A	28.4 in.	26.0 in.
B	7.0 in.	7.0 in.
C	32.0 in.	32.0 in.
D	23.0 in.	23.0 in.
E	29.4 in.	-
F	75.5 in.	67.5 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

FASTENER, 1/4 TURN



OVERVIEW

The 1/4-turn fastener serves to replace Velcro as a means of securing or closing a variety of items used in the EVA environment.

OPERATIONAL COMMENTS

1/4-turn fasteners are used to meet the strict cleanliness requirements of the Hubble Space Telescope (HST) program. They allow for one-handed operation by the gloved hand of the crewmember without adding significant bulk or weight to an assembly. 1/4-turn fasteners are used on the fuse transfer containers, the tool caddy with french hooks, and the cushioned tool board no. 1 from the HST program.

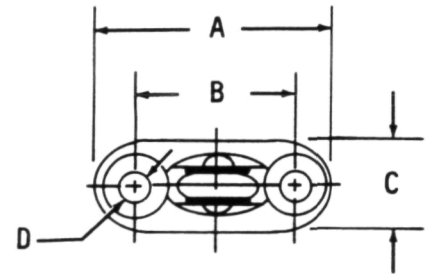
CONTENTS

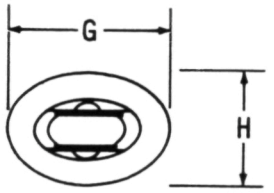
Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

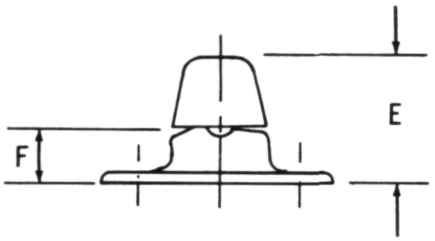
FASTENER, 1/4-TURN

Technical Information	
Part number	SO22MF2209-01 SO22MF2209-04
Weight	SO22MF2209-01 0.014 lb SO22MF2209-04 0.023 lb
Material/ construction	Male fastener - nickel plated brass Female eyelet - stainless steel
Temperature range	-150° to +250° F (operational)
Availability	Flight specific

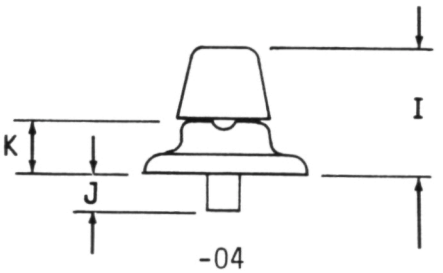
Dimensional Data	
A	1.250 in.
B	0.875 in.
C	0.480 in.
D	0.165 in. dia
E	0.680 in.
F	0.280 in.
G	0.780 in.
H	0.540 in.
I	0.900 in.
J	0.210 in.
K	0.510 in.







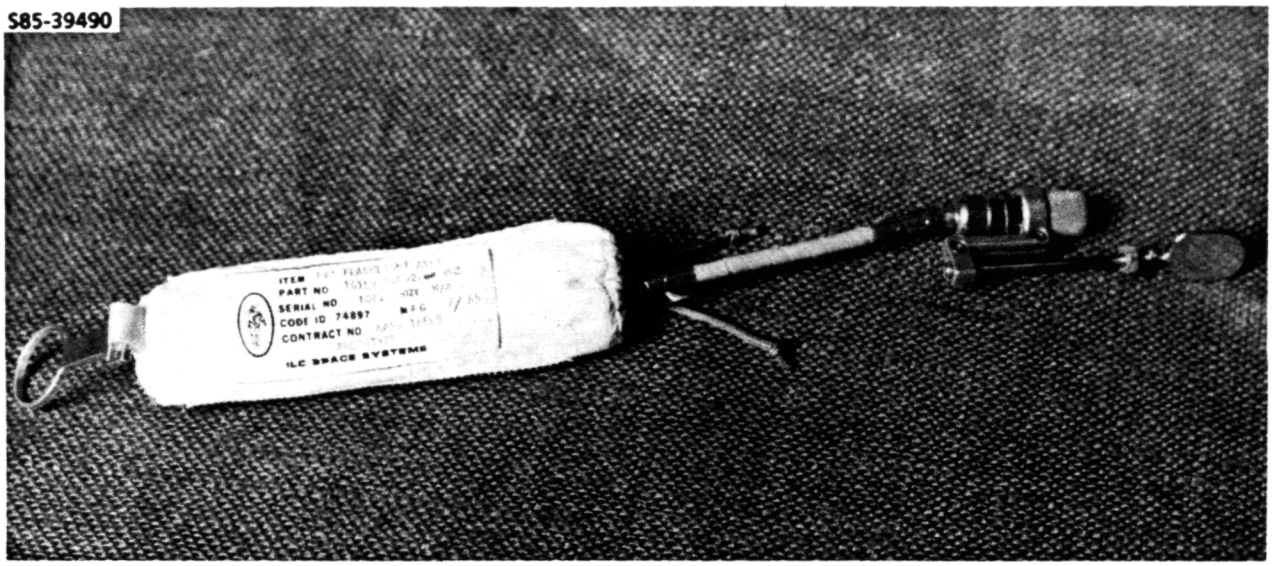
-01



-04

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

FLASHLIGHT



OVERVIEW

The EVA flashlight is a handheld, portable light source used by crewmembers to illuminate hard-to-reach areas.

OPERATIONAL COMMENTS

The EVA flashlight bulb casing and base are connected by a flexible neck, which can be bent at the desired angle by the crewmember. A mirror extends outward from the bulb end to aid the crewmember in seeing the item being illuminated. The flashlight is turned on by rotating the bulb assembly manually. It is stowed in the middeck during launch and entry and on a tool board or in the EVA bag during EVA.

The EVA flashlight base is covered with hook Velcro and has a guide pull to provide a means of attachment. A thermal garment covers this portion of the flashlight to protect the battery from temperature extremes during EVA. The garment also has Velcro and a guide pull.

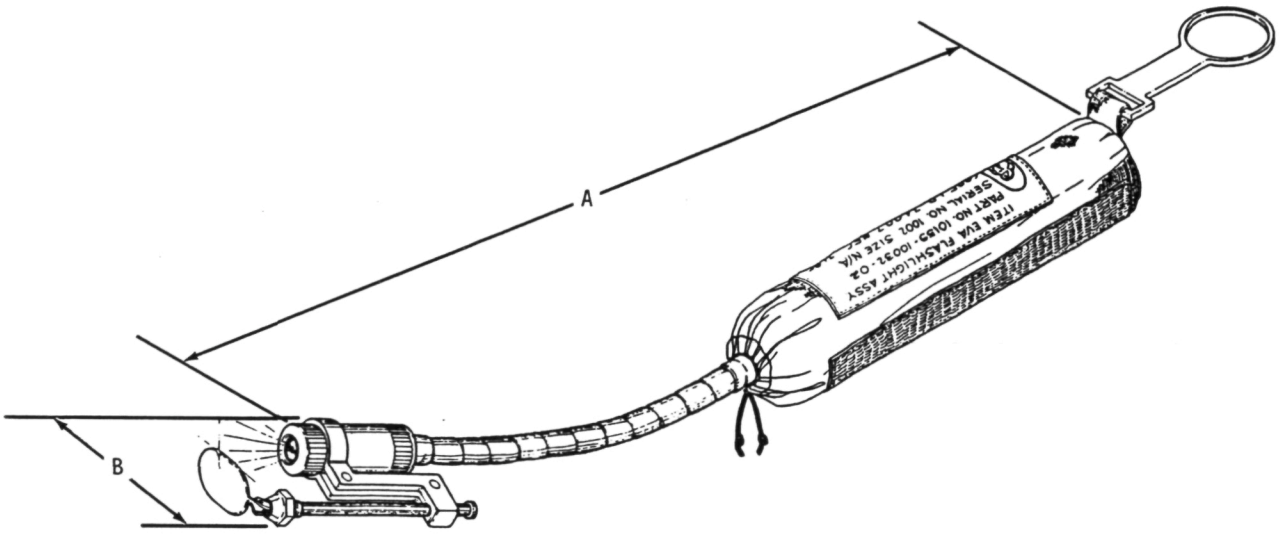
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483-2589
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

FLASHLIGHT

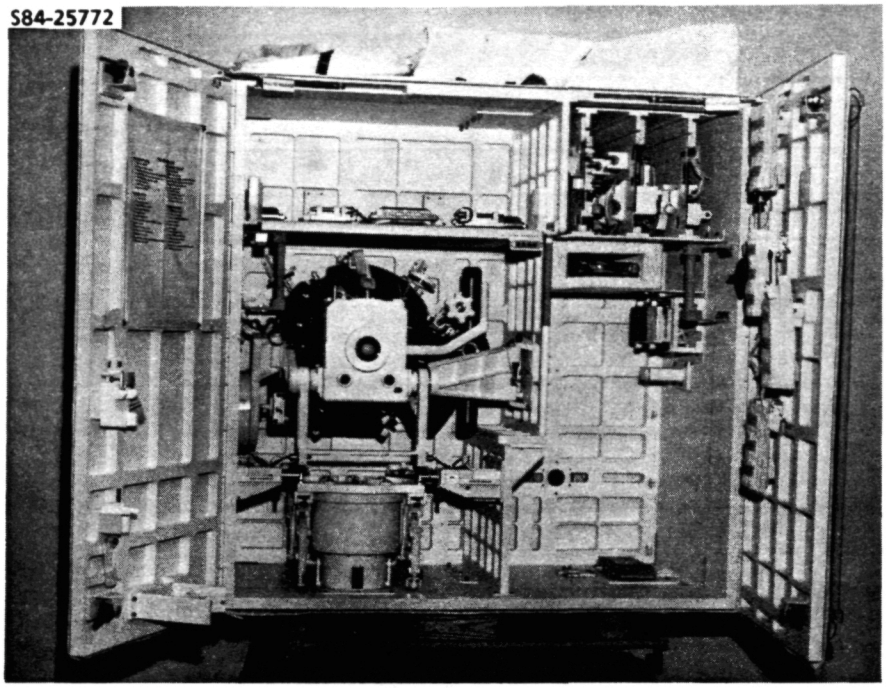
Technical Information	
Part number	10159-10032-02
Weight	0.26 lb
Battery	Two AA alkaline wrapped with Teflon and Kapton, 1.5 V each
Battery life	2 yr
Lamp	Standard flashlight bulb
Operation	Rotate bulb housing
Quantity flown	One for STS 41-G, 51-A, 51-I
Stowage	Middeck locker
Availability	Flight specific

Dimensional Data	
A	12.00 in. true length
B	1.40 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

FLIGHT SUPPORT SYSTEM LOCKER



OVERVIEW

The flight support system (FSS) locker stows tools and equipment used for satellite repair. The locker mounts on the FSS cradle at station X_{FS} 85.70 (Orbiter X_O - 1160.9) for launch and entry.

The FSS locker is designed for crewmember access and use. It includes a portable foot restraint, handholds, and doors for removing and replacing tools. The locker is normally used with a separate FSS foot restraint to aid crewmember access.

OPERATIONAL COMMENTS

The FSS locker protects its contents with thermal insulation and by transmitting launch and entry loads through its connection with the cradle. Brackets, latches, and mounting hardware restrain the tools and equipment stowed in the locker. This locker flew on STS 41-C and contained the trunnion pin attachment device (TPAD), main electronics box (MEB) replacement box, two module servicing tools (MST's), an EVA power tool, four tool caddies, and three tool boards.

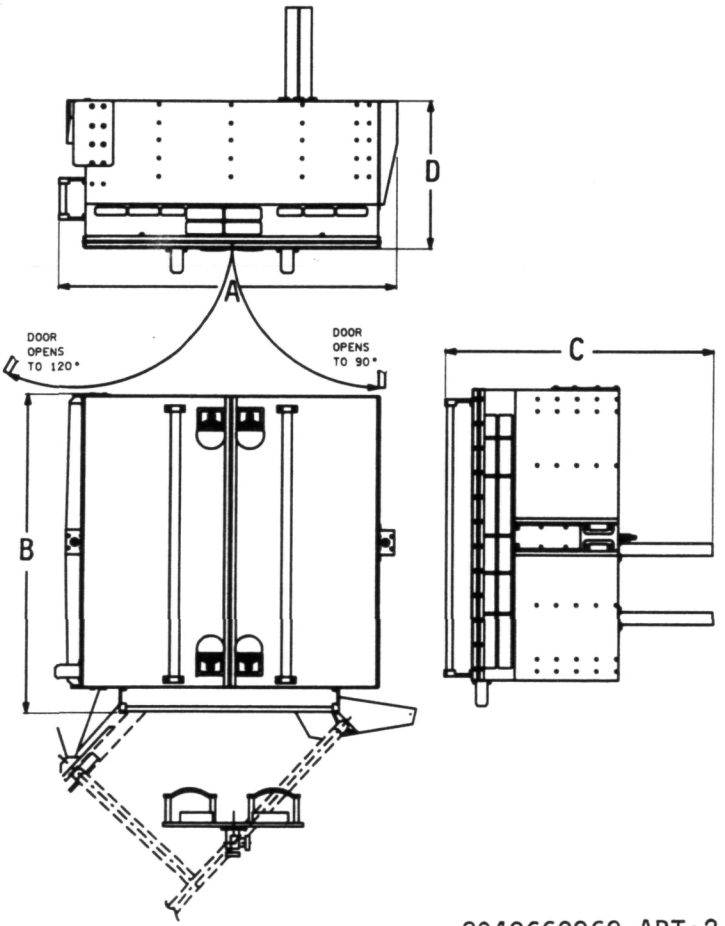
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

FLIGHT SUPPORT SYSTEM LOCKER

Technical Information	
Part number	10172-20001-01
Weight	Empty - 442.6 lb Packed - 789.0 lb
Material	Aluminum honeycomb
MFG structure wt	176.6 lb
Typical items stowed in FSS locker	TPAD, MST (2), MEB with panel, manipulator foot restraint tool boards (3), tape strips in caddy, EVA scissors, power hand tools (2), shrouded screwdriver extension, hex allen drive extension, crow's foot, pin straightener, MEB panel support bracket, thermal patch, pin connector installation tool, pin connector removal tool, essex ratchet tool, large trash bag, 7/16-in. socket extension, drill bit, tape caddy, open end wrenches (2)
Quantity flown	One for STS 41-C
Stowage	Cargo bay
Availability	Flight specific

Dimensional Data	
A	53.86 in.
B	57.65 in.
C	43.87 in.
D	23.00 in.

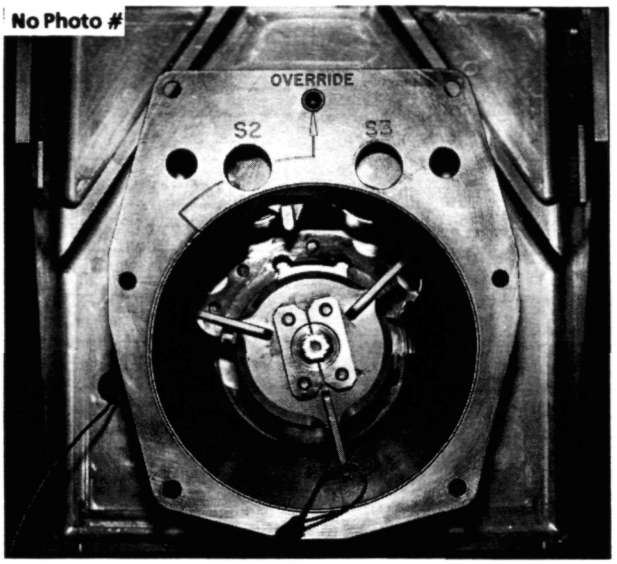


2040660060.ART;2

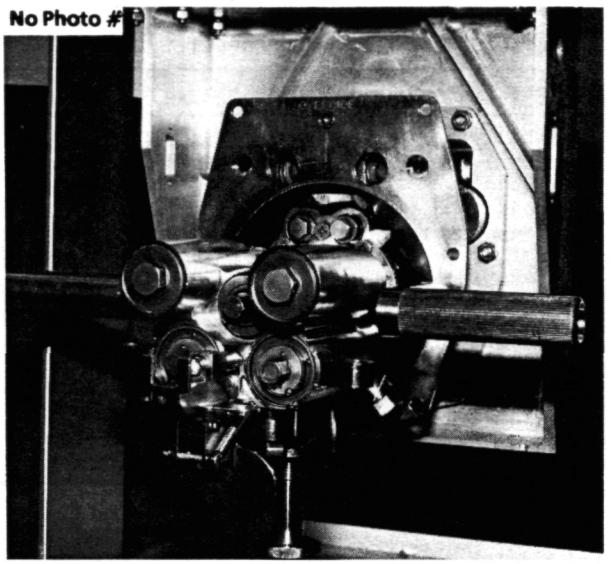
ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

FLUID CONNECTOR, EVA

No Photo #



No Photo #



OVERVIEW

The EVA fluid connector is a coupling device designed for transferring fluids and low pressure gases. Each half of the fluid connector has three manual valves and pressure transducers to check valve integrity. Triply redundant interface seals between coupling halves have pressure ports to check seal integrity. Interlocks prevent valve opening while a coupling is disengaged and prevent coupling disengagement with a valve open.

OPERATIONAL COMMENTS

The fluid connector is connected by first aligning the tanker coupling (male) and the spacecraft coupling (female) halves and then engaging. By means of the handle grips, the tanker coupling is rotated clockwise approximately 40° until the handles are horizontal. The locking pin is then rotated clockwise. The seal integrity is checked, and the safety lever is pulled forward and down exposing the flow control valves. The valves are opened in the following order: T-3, T-2, T-1/S-1, S-2, S-3, allowing fluid transfer. The operations, from rotating the locking pin through opening the valves, are clearly labeled 1 through 7 on the face of the coupling. These steps are reversed (7 to 1) to close the valve and remove the tool. A spacecraft coupling has been installed on the Gamma Ray Observatory (GRO). The tank coupling will eventually be installed on a hydrazine tanker for a GRO servicing mission.

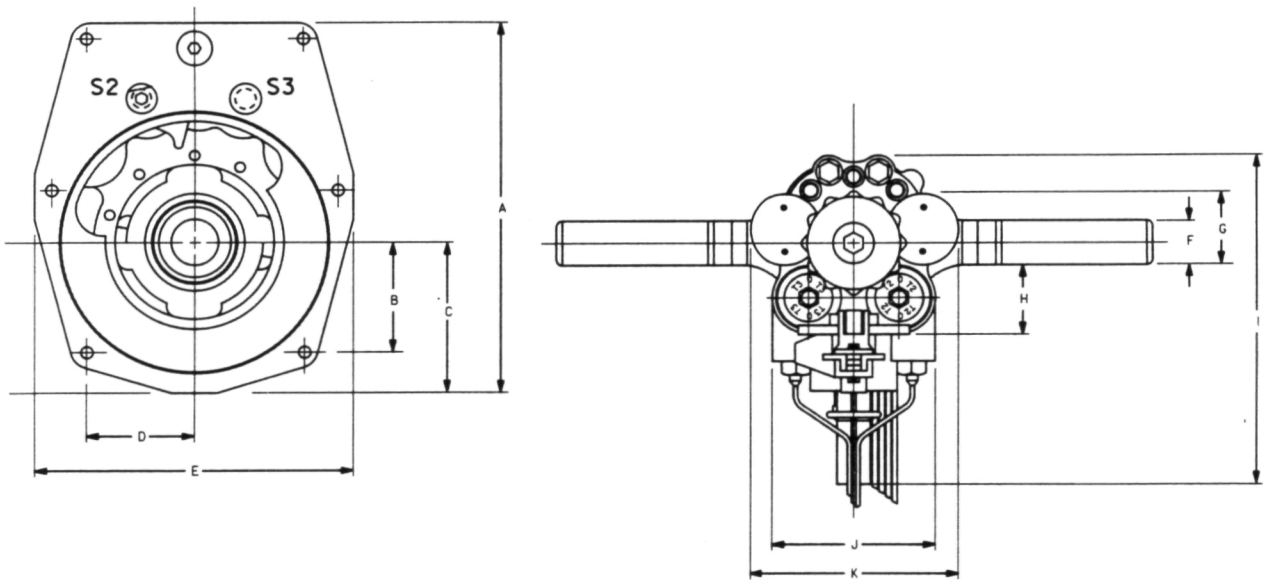
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597.
Technical: J. B. Henderson, NASA/EP4, (713) 483-9008
Source: Fairchild Control Systems Company, (213) 643-9222

FLUID CONNECTOR, EVA

Technical Information	
Part number	84315000-513
Weight	16.0 lb max.
Material	Stainless steel
Operating pressure	500 psig nominal, 600 psig maximum
Operating temperature	40° F minimum, 70° F nominal, 120° F maximum
Flow rate	10 gpm nominal, 20 gpm maximum
Availability	Flight specific

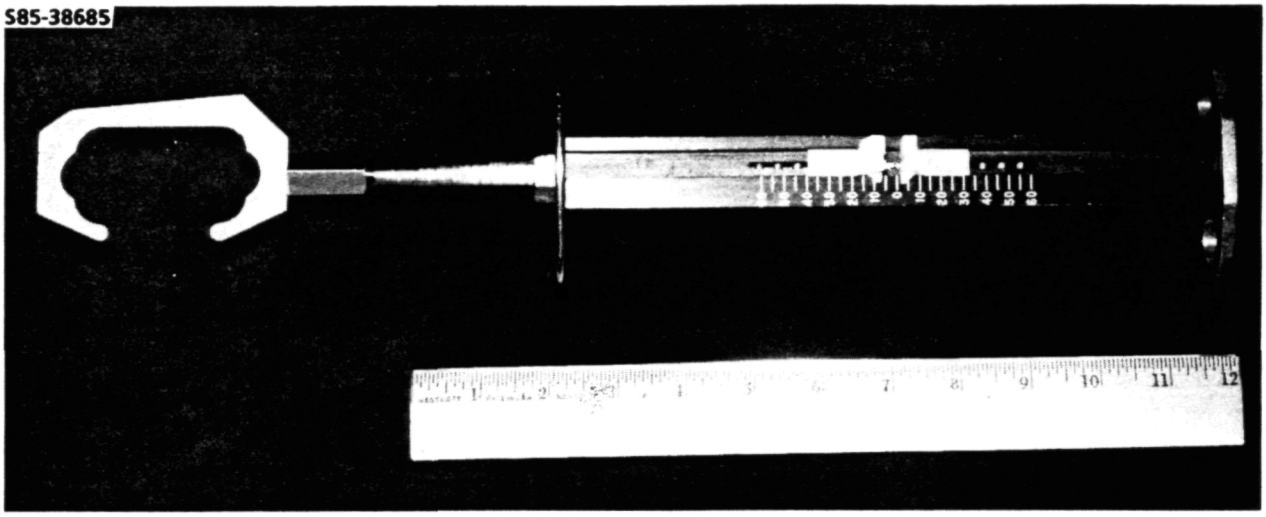
Dimensional Data	
A	7.820 in.
B	2.330 in.
C	3.160 in.
D	2.340 in.
E	6.820 in.
F	1.000 in.
G	1.600 in.
H	1.500 in.
I	7.500 in.
J	3.700 in.
K	4.800 in.



204660061.ART, 2

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

FORCE MEASUREMENT TOOL



OVERVIEW

The force measurement tool was used to measure crew push-pull strength capability. The tool is basically a spring scale which measures up to 60 pounds in either direction (push or pull). At one end is a hook with a 1/4-inch opening; at the other end is a plate with two tether points. Two sliding stops record the force applied.

OPERATIONAL COMMENTS

The force measurement tool was developed for use with the EVA crewmember positioned in the manipulator foot restraint. Its purpose was for the EVA crewmembers to apply a force at the tip of the RMS by pulling or pushing on the arm with the tool. The force read by the crewmembers was then compared against the readings from the RMS joint actuators to verify proper readings from the RMS.

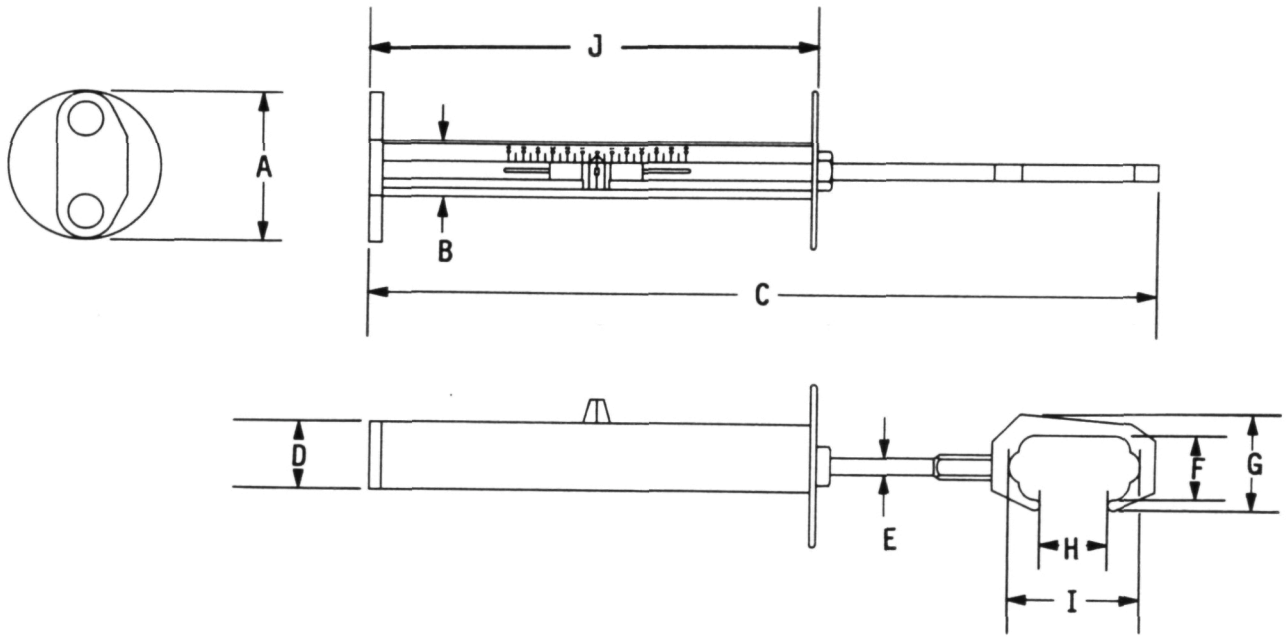
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: T. Ross, NASA/ES6, (713) 483-8941
Source: R. E. McElyea, NASA/ES6, (713) 483-8964

FORCE MEASUREMENT TOOL

Technical Information	
Part number	SED 33103285-301
Weight	2.0 lb
Material	Aluminum housing, steel shaft
Measurement capability	60 lb
Availability	Flight specific

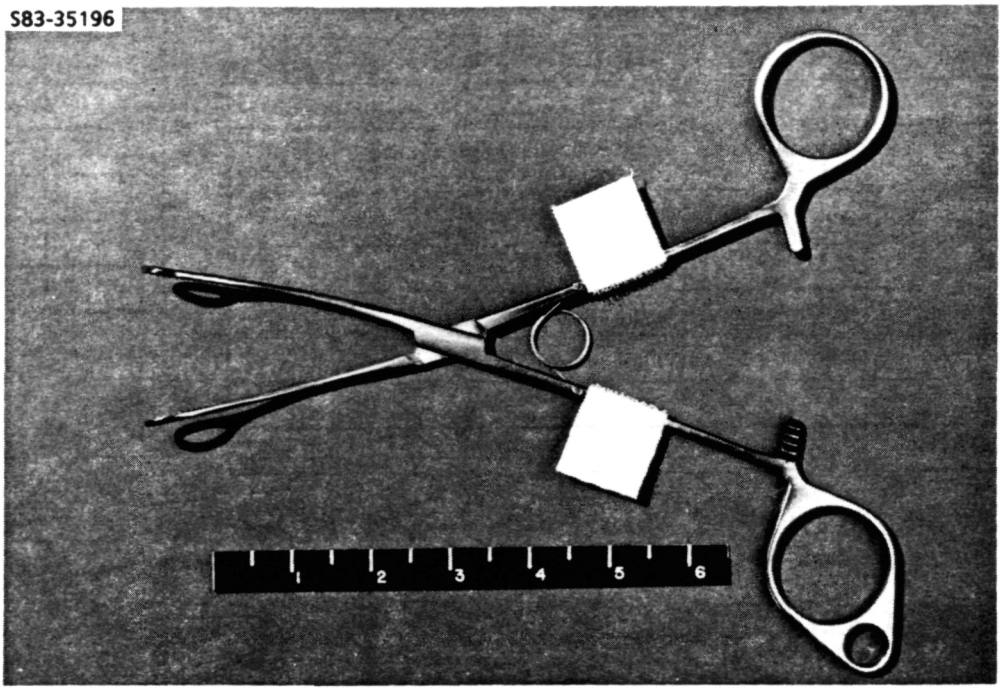
Dimensional Data	
A	3.25 in.
B	1.20 in.
C	16.88 in.
D	1.50 in.
E	0.35 in.
F	1.40 in.
G	2.10 in.
H	1.45 in.
I	2.85 in.
J	9.50 in.



204660062.ART,4

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

FORCEPS



OVERVIEW

The forceps are a common medical instrument modified for EVA use. They have 1/2- by 1-inch elliptical tips which are serrated for gripping, a sawtooth locking mechanism that allows adjustable clamping positions, and a spring to force the handles apart. They are equipped with Velcro tabs and have a ring for tether attachment.

OPERATIONAL COMMENTS

The forceps are a general usage tool for disconnect and jam removal. They have an approximate 2-3/4-inch opening for convenient one-handed operation, but it is possible to open them wider. This tool is part of the normally manifested STS equipment. They are wrapped in a Velcro-lined tool caddy along with the pry bar and stowed in the starboard provisions stowage assembly (PSA).

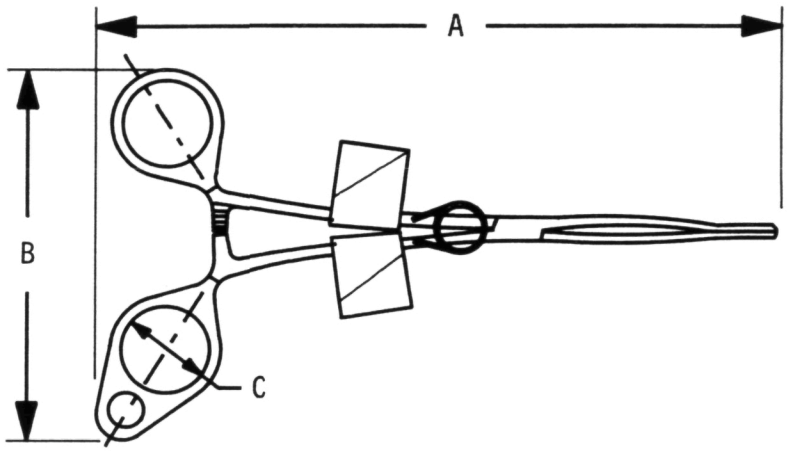
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: J. Madden, Rockwell/Houston, (713) 282-5300

FORCEPS

Technical Information	
Part number	V628-650877-001 or SDD33103445-301
Weight	0.2 lb
Material/ construction	Tool steel with Velcro tabs and tether rings
Tip	Elliptical 1 by 1/2 in.
Maximum opening	2-3/4 in.
Temperature range	-200° to 250° F (operational)
Quantity flown	One in the starboard PSA
Available	Standard

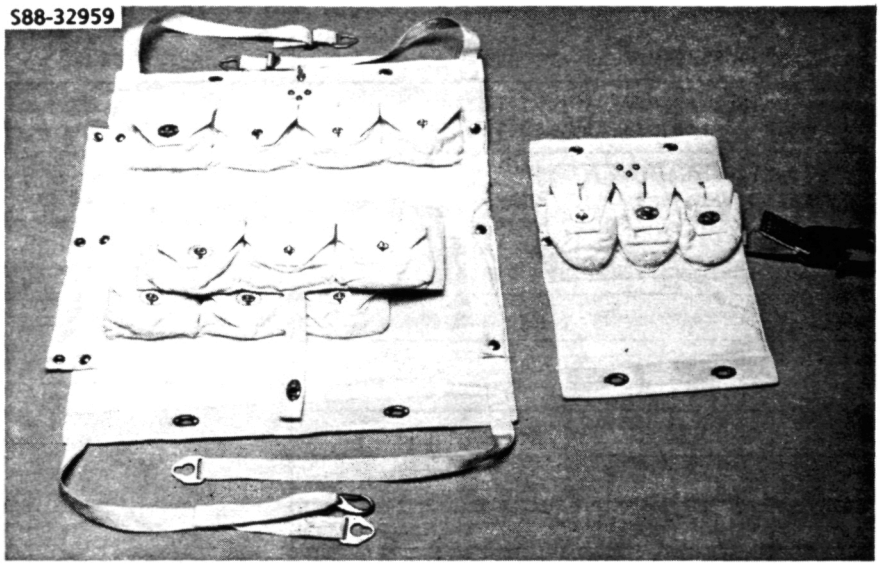
Dimensional Data	
A	9.90 in.
B	5.60 in.
C	1.44 in.



204660063.ART, 4

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

FUSE TRANSFER CONTAINER



OVERVIEW

The electrical power/thermal canister experiment (EP/TCE) fuse transfer container (10181-10027-01) provides containment and transport of spare fuses to and from the EP/TCE box at bay 4 of the Hubble Space Telescope (HST). The fabric bag provides thermal protection from -40° to 160° F. The container consists of three insulated pockets: two for the replacement fuses and one for the initial changeout fuse.

The power distribution unit (PDU) fuse transfer container (10181-10028-01) is a thermally protective bag in which replacement fuses for the power distribution unit of the HST are stowed and transported. Twelve fuses in the PDU are replaced during a maintenance and repair mission. The container consists of 13 insulated pockets: 12 for the replacement fuses and 1 for the initial changeout fuse. The fuses are protected from -40° to 160° F.

OPERATIONAL COMMENTS

The fuse transfer containers are fabricated from a multiple layer insulation layup using eight layers of aluminized Mylar. Each container folds up for stowage. The container is tethered to the EVA crewmember until replacement operations are underway. At this point the crewmember can unfold the container and attach it to the work area as desired. One fuse is removed from the telescope and stowed in the one empty pocket. Then the exchange of new fuses and old fuses continues. The pockets are numbered to keep track of which fuses have been changed out.

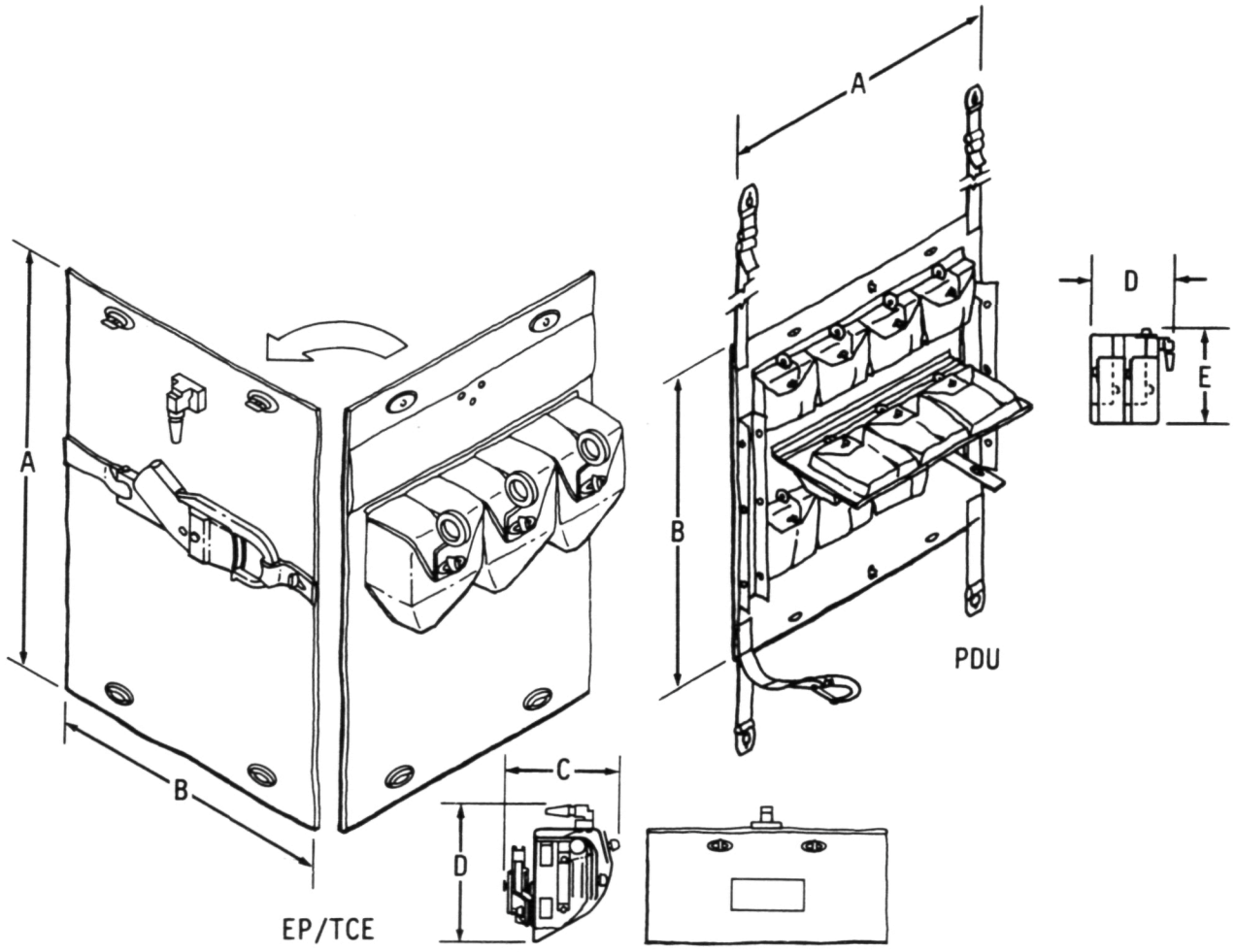
CONTACTS

Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

FUSE TRANSFER CONTAINER

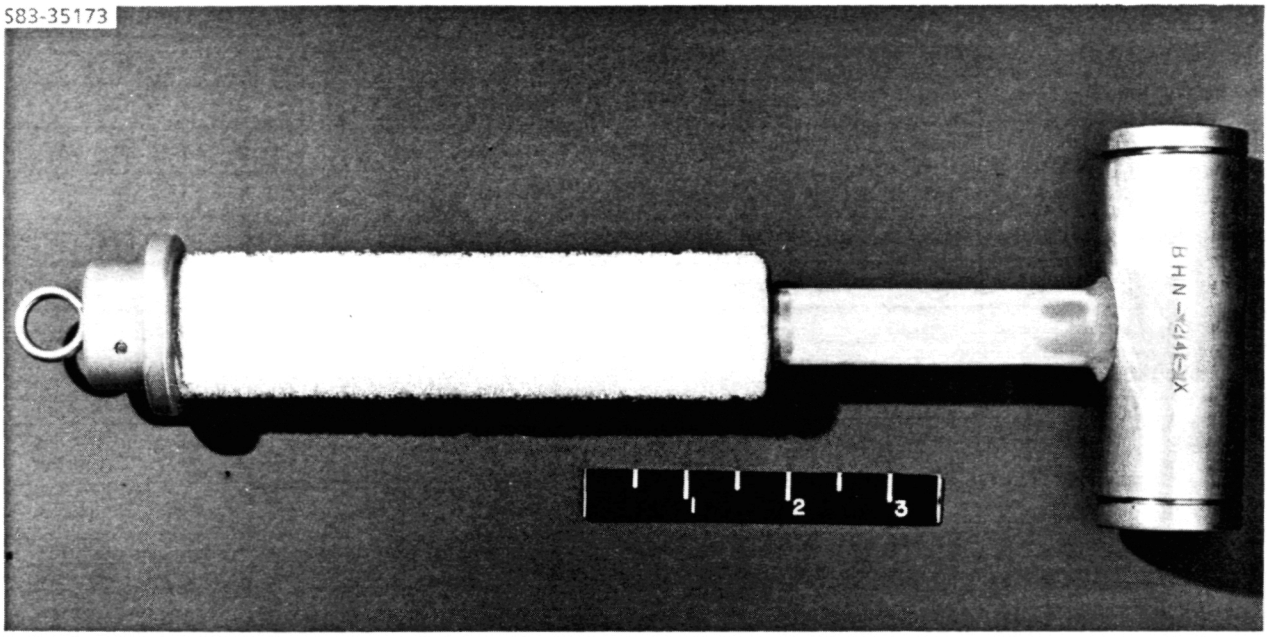
Technical Information	
Part number	10181-10027-01 (EP/TCE) 10181-10028-01 (PDU)
Weight	10181-10027-01 1.71 lb 10181-10028-01 4.85 lb
Material/ construction	Teflon cloth Nomex tape and cloth Ortho fabric Teflon-coated fiberglass Aluminum stiffener plates
Temperature range	-150° to +250° F (operational)
Thermal control range	-40° to +160° F
Availability	Flight specific

Dimensional Data		
	10181-10027	10181-10028
A	15.00 in.	21.12 in.
B	10.50 in.	22.75 in.
C	5.20 in.	6.50 in.
D	6.00 in.	5.88 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

HAMMER



OVERVIEW

The hammer is a common tool modified for EVA use. The handle is built up and wrapped with Velcro to provide a positive grip for the gloved hand. A tether ring is mounted on the end of the handle for tethering.

OPERATIONAL COMMENTS

The hammer is a general purpose tool used for disconnect and jam removal. This tool is part of the normally manifested STS equipment. It is wrapped in a Velcro-lined tool caddy along with the probe and is stowed in the starboard provisions stowage assembly (PSA).

CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: J. Madden, Rockwell/Houston, (713) 282-5300

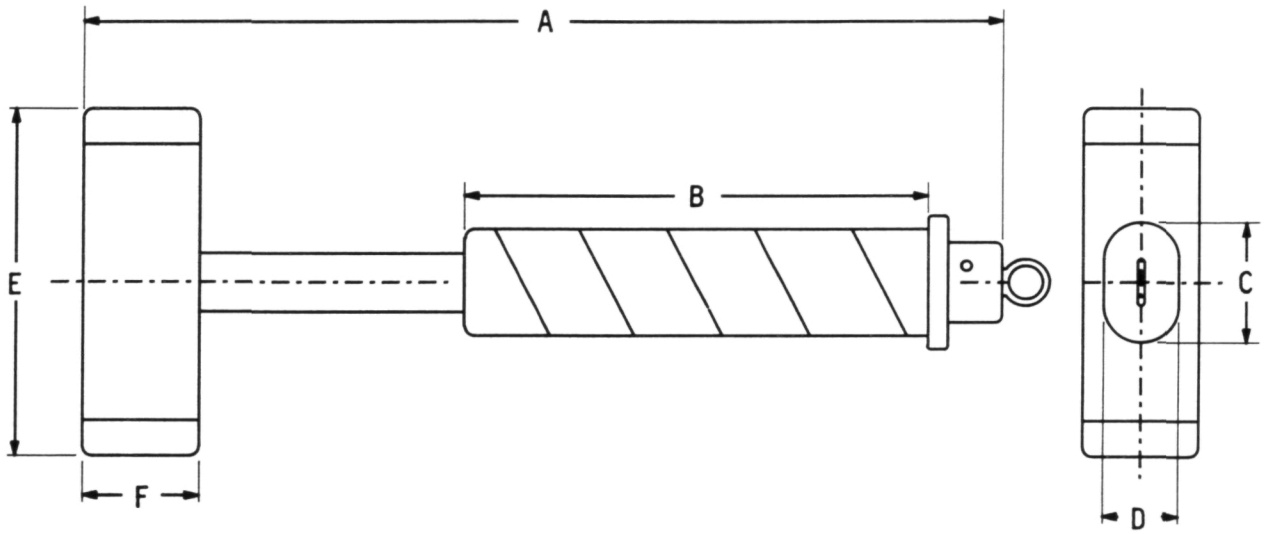
Section G
PAGE INTENTIONALLY BLANK

PRECEDING PAGE BLANK NOT FILMED

HAMMER

Technical Information	
Part number	V628-650875-004 or SDD33103433-301
Weight	2 lb
Material/ construction	Handle - aluminum and fiberglass wrapped with Velcro Head - 1-1/4-in. diameter brass
Temperature range	-200° to 250° F (operational)
Quantity flown	One in the starboard PSA
Availability	Standard

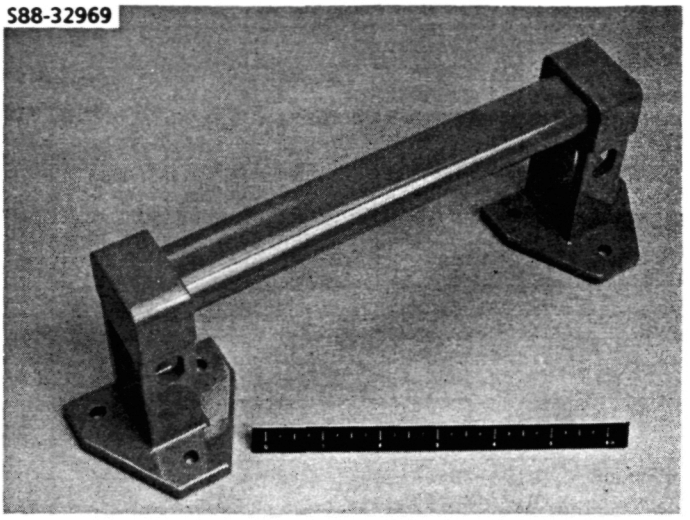
Dimensional Data	
A	11.000 in.
B	5.600 in.
C	1.750 in.
D	1.250 in.
E	3.875 in.
F	1.250 in.



204660066.ART;6

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

HANDRAIL, EVA



OVERVIEW

The EVA handrail is an assembly of a left- and right-hand standoff bracket and tubing, designed to allow crewmember translation and restraint along a variety of structures. A middle bracket is incorporated into the design when additional structural support is required. Handrails are used at various points in the Orbiter cargo bay, on tool containers, and on satellites as a transfer aid, stabilizer, and tether point. All EVA handrails are painted yellow for easy visual identification.

OPERATIONAL COMMENTS

Many different EVA handrails have been used in the Space Shuttle EVA program. This particular handrail represents one of the better examples of handrail design. It is included in this document as a recommended standard handrail for any application. The Hubble Space Telescope (HST) tool box uses this handrail. Some of its features include:

1. The handrail tubing can be cut to measure and is secured at the desired points by the brackets.
2. Hooks and end effectors can be attached over the standard cross-section tubing.
3. Tether points have been integrated into the standoff brackets.
4. Damaged tubing and brackets are easily replaceable.

For more detailed information on handrail design criteria, refer to NSTS 07700, vol. XIV, appendix 7, Description and Design Requirements - EVA.

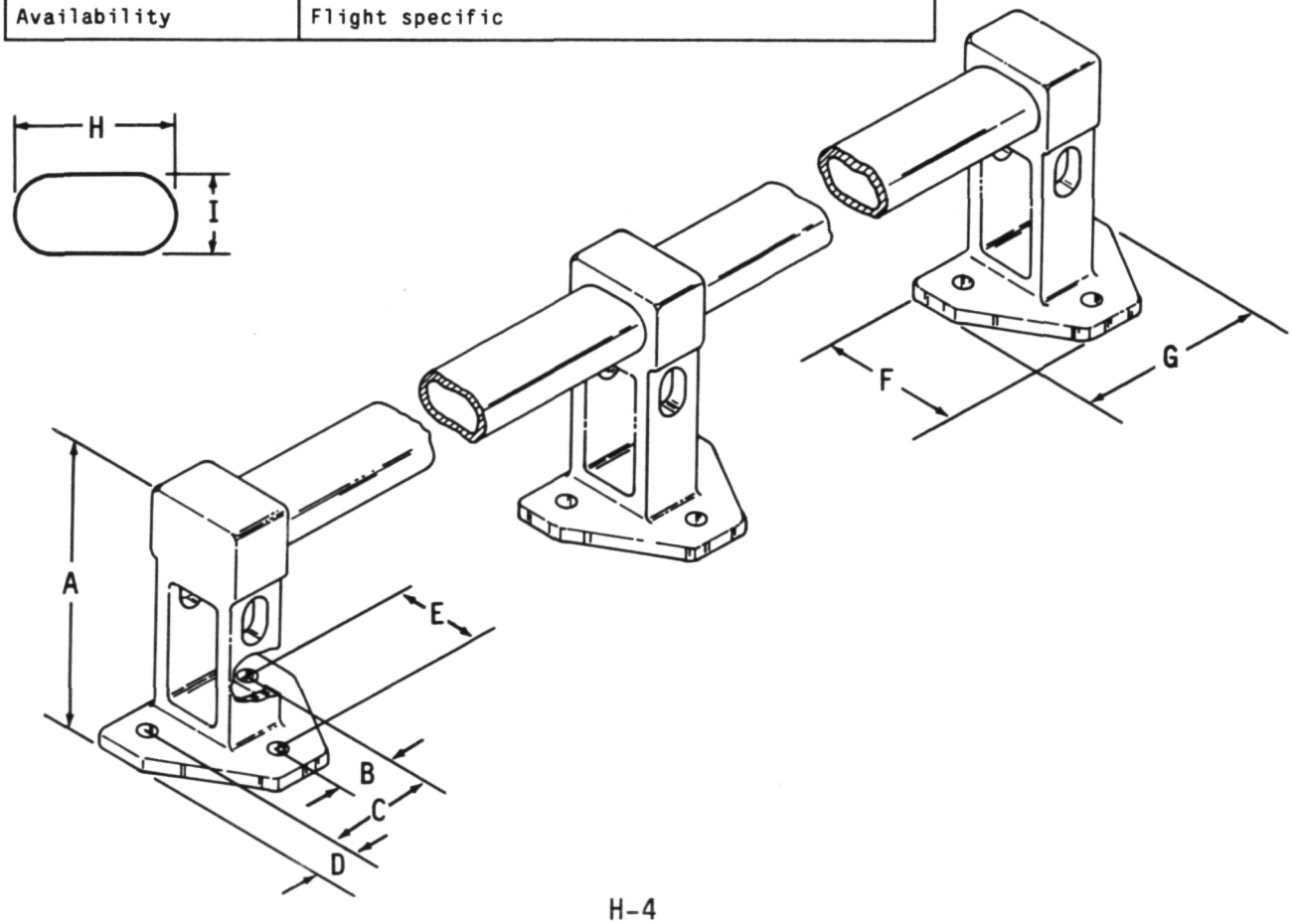
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

HANDRAIL, EVA

Technical Information			
Part number	Tube	10174-20036-01	9.72 in.
		10174-20036-02	14.98 in.
		10174-20036-03	19.72 in.
		10174-20036-04	25.97 in.
		10174-20036-05	32.77 in.
		10174-20036-06	51.22 in.
		10174-20036-07	61.01 in.
	Bracket	10174-20023-01	Right-hand
		10174-20023-02	Left-hand
		10174-20023-03	Middle
Weight	Tube	10174-20036-01	0.19 lb
		10174-20036-02	0.29 lb
		10174-20036-03	0.38 lb
		10174-20036-04	0.50 lb
		10174-20036-05	0.63 lb
		10174-20036-06	0.98 lb
		10174-20036-07	1.16 lb
	Bracket	10174-20023-01	0.54 lb
		10174-20023-02	0.54 lb
		10174-20023-03	0.48 lb
Material/ construction	Aluminum		
Temperature range	-150° to +250° F (operational)		
Availability	Flight specific		

Dimensional Data	
A	4.100 in.
B	1.000 in.
C	2.000 in.
D	0.500 in.
E	1.625 in.
F	2.630 in.
G	3.000 in.
H	1.380 in.
I	0.750 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

HARPOON, EASE TRUSS NODE

S85-42953

OVERVIEW

The EASE truss node harpoon was developed for use during the Experimental Assembly of Structures with EVA (EASE) flight experiment. The harpoon is similar in design to a large pip pin. A tether ring is attached to the shaft near to midpoint. There is a cylindrical handle for releasing the harpoon from the structure.

OPERATIONAL COMMENTS

The harpoon is inserted by pressing the shaft into the beam hole. The end of the handle must be pulled to release the shaft from the hole.

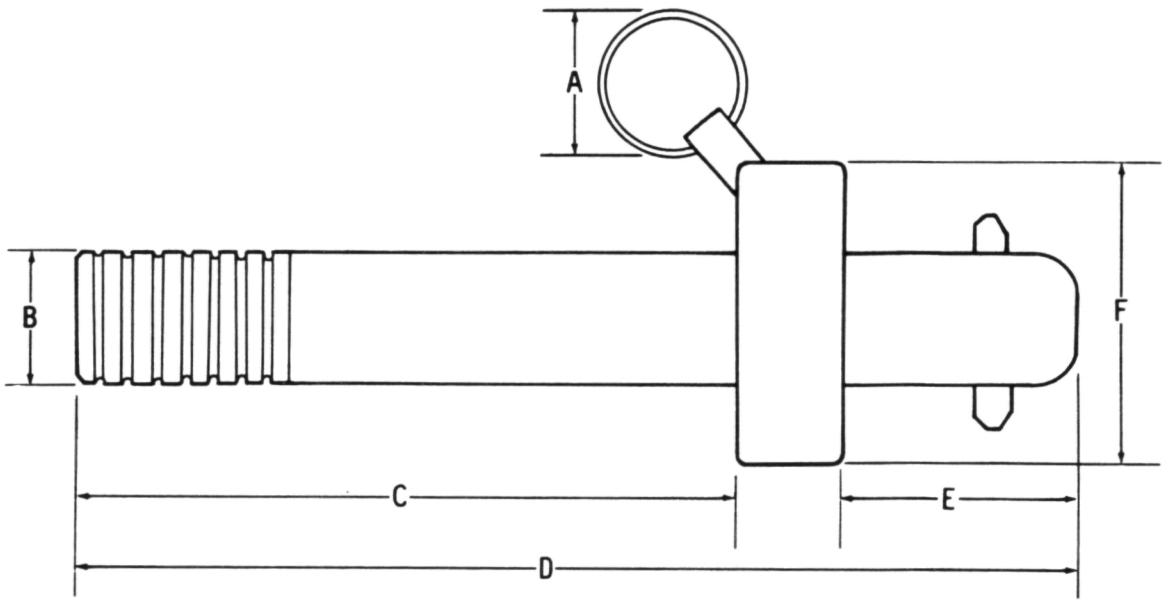
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: M. Withey, ILC Space Systems, (713) 488-9080
Source: Dr. D. Akin, Massachusetts Institute of Technology, MS 33-309, Cambridge, MA 32139, (617) 253-2263

HARPOON, EASE TRUSS NODE

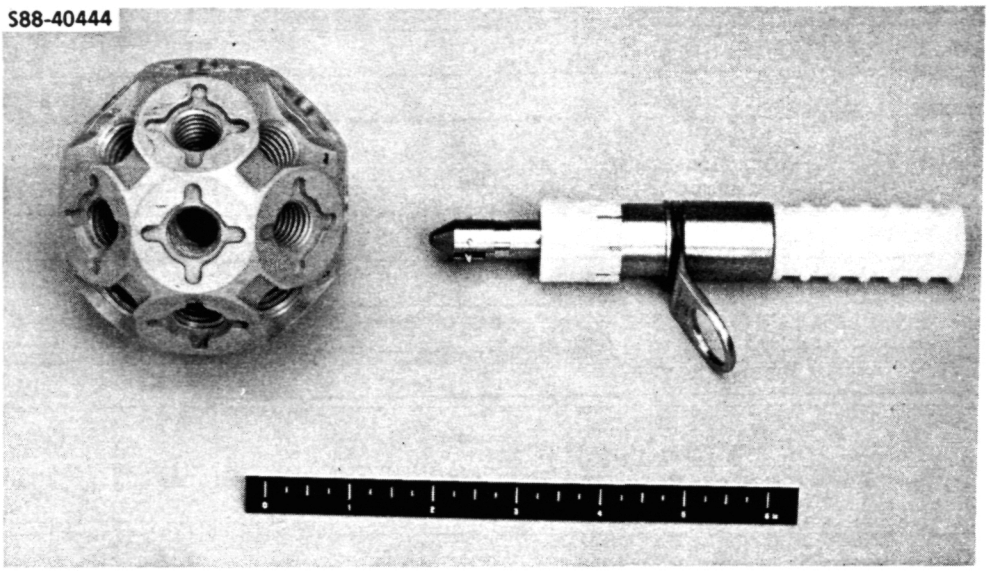
Technical Information	
Part number	Not available
Weight	0.15 lb
Material/ construction	Stainless steel/aluminum alloy
Force	Insertion < 1 lb Removal < 2 lb
Design temperature range	-250° to +220° F
Availability	Flight specific

Dimensional Data	
A	1.125 in.
B	1.000 in.
C	5.125 in.
D	8.000 in.
E	2.000 in.
F	2.000 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

HARPOON, SPACE STATION FREEDOM TRUSS NODE



OVERVIEW

The Space Station Freedom truss node harpoon is a tethering prototype device designed to fit into the open node holes of the Space Station truss structure and latch into place. It provides a tethering location at the nodes for use in EVA and also provides a means of tethering the nodes for Space Station construction. A spring-loaded bumper keeps the node tight on the harpoon until it is released.

OPERATIONAL COMMENTS

The harpoon is attached to the Space Station node by simply pushing it into any open hole location until it latches in place. To release the harpoon, pull the handle at the base outward until the harpoon disengages.

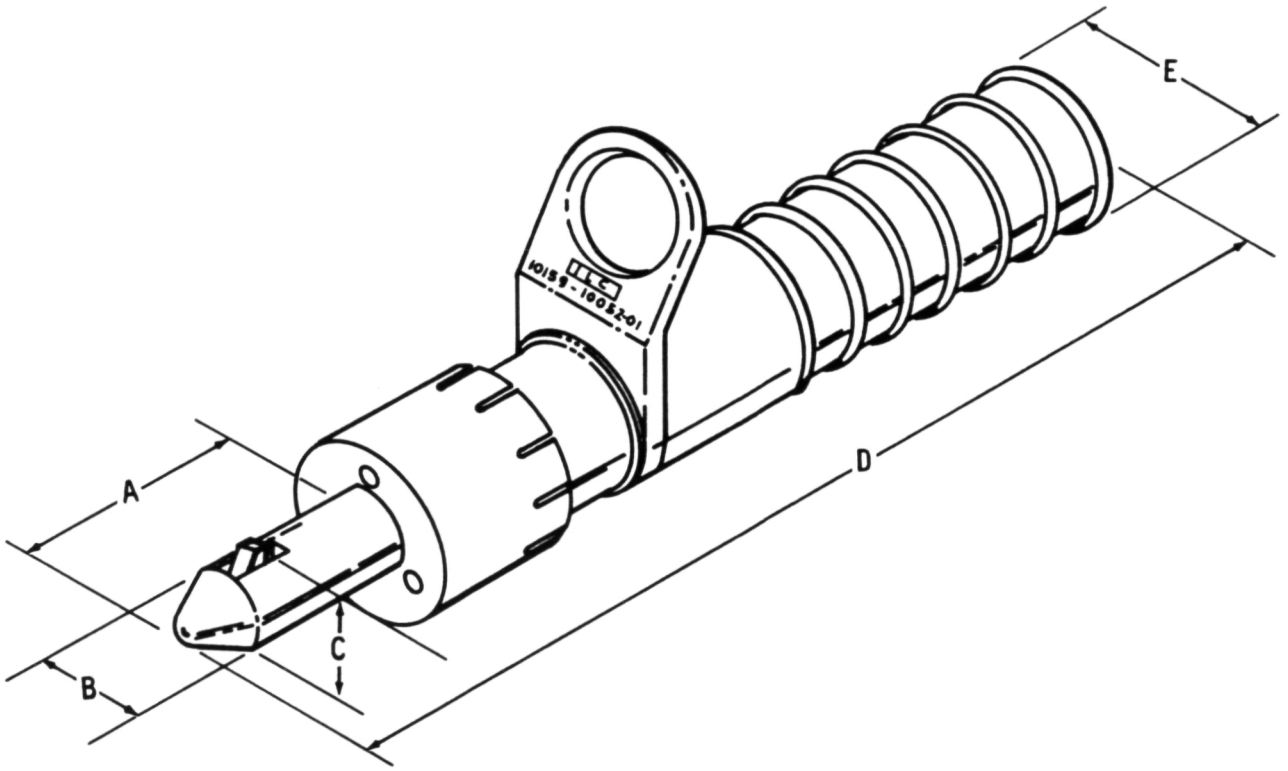
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

HARPOON, SPACE STATION FREEDOM TRUSS NODE

Technical Information	
Part number	10159-10052-01
Weight	0.15 lb
Material/ construction	Delrin Stainless steel Aluminum
Temperature range	-150° to +250° F (operational)
Availability	Developmental

Dimensional Data	
A	1.40 in.
B	0.50 in.
C	0.70 in.
D	6.65 in.
E	1.00 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

HOOK, FRENCH

OVERVIEW

French hooks, also known as snap hooks, are used in a variety of EVA applications. They serve to tether tools which incorporate a tether ring. Small french hooks (shown above) are typically used with retracting tethers on the wide range of tool caddies. Larger 4-inch french hooks are used on the payload retention device and snatch block. These hooks are not to be used as safety tether hooks or for applications where a lock-lock feature is required. They should be used only in applications where a tool or equipment is to be restrained temporarily.

OPERATIONAL COMMENTS

Each hook is designed for ease-of-operation. The hook opens when pressure is applied to the bail. After the hook passes over the item it is to tether, the bail snaps closed. Hooks commonly used for EVA purposes are functionally rated from 880 to 2000 pounds, depending on the size of the hook. An example of its use is the restraint of the EVA power tool on a manipulator foot restraint (MFR) tool board retractable tether. The EVA power tool can be used with the retractable tether or the french hook can be removed and the tool used on a standard EVA wrist tether.

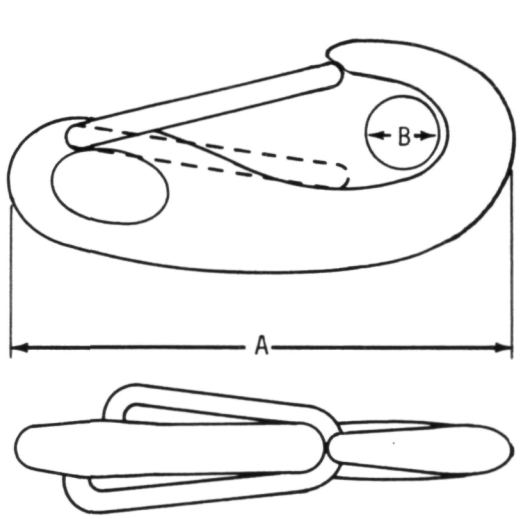
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

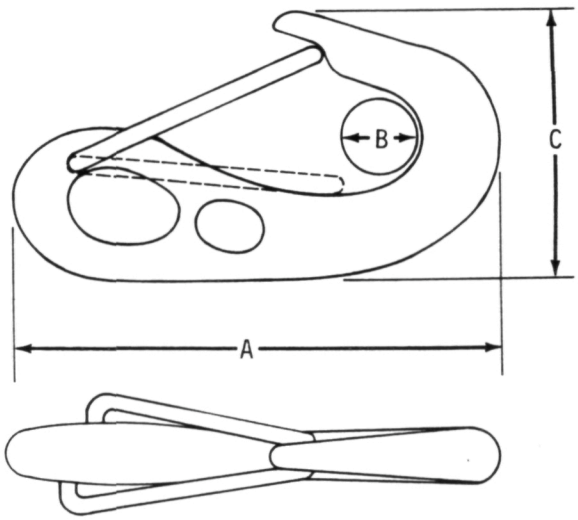
HOOK, FRENCH

Technical Information	
Part number	ST20H1387-05/06 (2 in. long) ST20H1387-01 (3 in. long) 10163-20057-01 (4 in. long)
Weight	ST20H1387-05/06 0.041 lb ST20H1387-01 0.135 lb 10163-20057-01 0.375 lb
Material	Drop forged stainless steel
Temperature range	-150° to +250° F (operational)
Functional limits	ST20H1387-05/06 880 lb ST20H1387-01 1760 lb 10163-20057-01 2000 lb
Availability	Flight specific

Dimensional Data			
	ST20H1387 05/06	ST20H1387 -01	10163-20057-01
A	2.00 in.	3.00 in.	4.00 in.
B	0.25 in.	0.41 in.	0.56 in.
C	-	-	2.18 in.



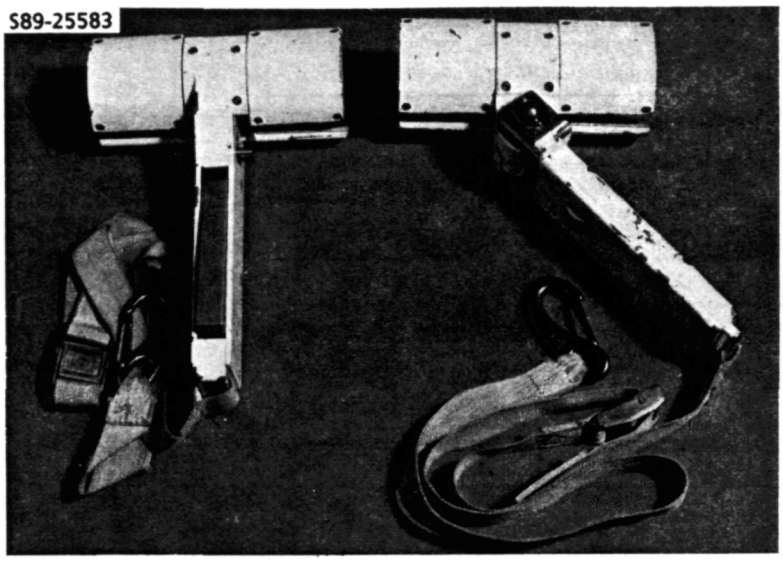
ST20H1387-01/05/06



10163-20057-01

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

HOOK, TRUSS STRUT



OVERVIEW

The truss strut hooks are prototype equipment tethers which are being designed specifically to attach to the 2-inch diameter truss members of the Space Station. The truss strut swivel hook (20159-10002-01) incorporates a pivoting handle, while the truss strut fixed hook (20159-10001-01) has a stationary handle.

OPERATIONAL COMMENTS

Each truss hook has two modes of operation: hard dock, which holds the hook in one location, and soft dock, which allows for a loose sliding fit. Each hook also has a 42-inch strap with a cam buckle to allow for strap length adjustment.

The handle of the truss strut swivel hook is designed to pivot 90° clockwise or counterclockwise in parallel with the truss member for a total travel of 180° in 30° increments. This feature provides maximum flexibility for tight areas, such as near the node.

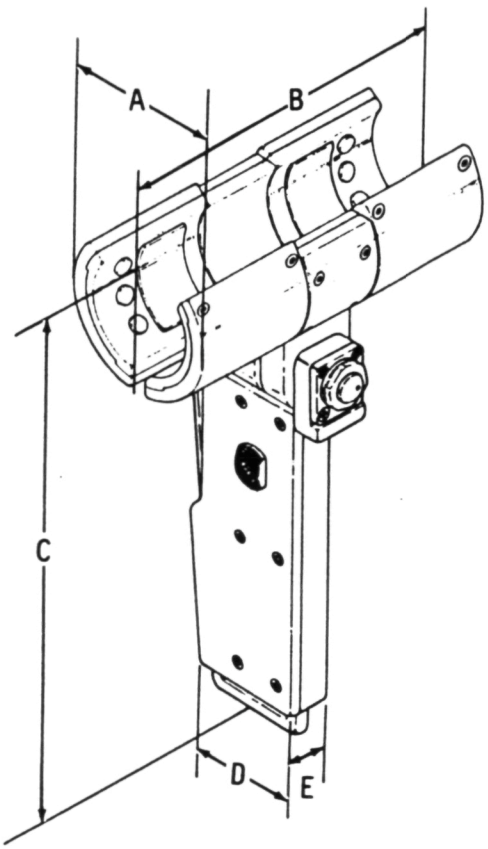
CONTACTS

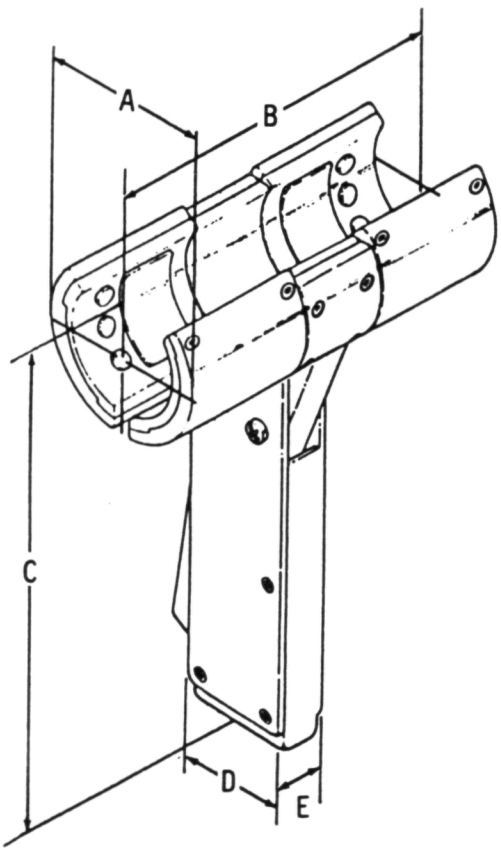
Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

HOOK, TRUSS STRUT

Technical Information	
Part number	20159-10003-01 (fixed) 20159-10002-01 (swivel)
Weight	20159-10003-01 2.18 lb 20159-10002-01 2.45 lb
Material/ construction	Aluminum bronze Stainless steel Vespel
Temperature range	-150° to +250° F (operational)
Tether length	42 in. (adjustable)
Availability	Developmental

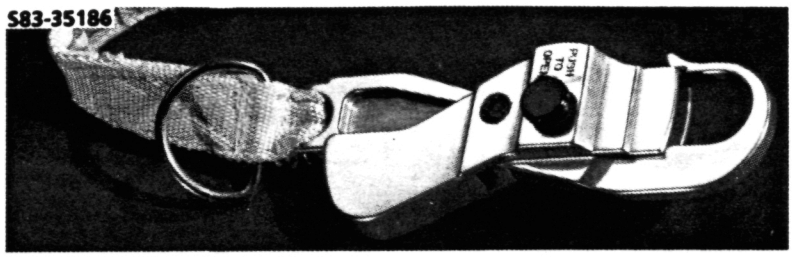
Dimensional Data		
A	1.97-3.10 in.	1.95-3.05 in.
B	6.000 in.	6.00 in.
C	8.750 in.	9.65 in.
D	1.810 in.	2.21 in.
E	0.875 in.	0.75 in.

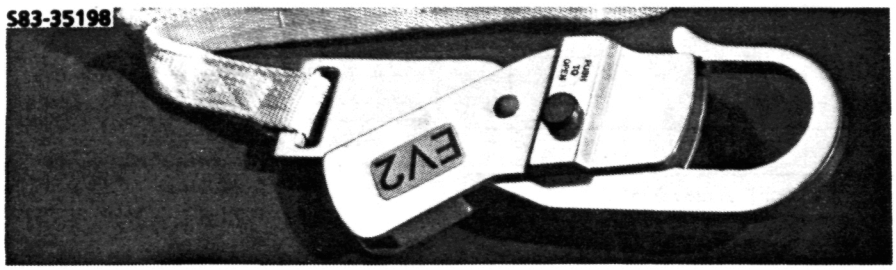




ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

HOOK, UNIVERSAL TETHER





OVERVIEW

The large and small universal tether hooks are designed for use in a variety of EVA applications. The hooks are designed with safety and reliability in mind, because they are primary restraints for crewmembers and equipment. 10181-10046-01 and 10181-10047-01 are used in the adjustable equipment tether for the Hubble Space Telescope (HST). The EVA waist and wrist tethers primarily use 9792-01 and 10151-20083-01. All configurations are functionally equivalent. The wrist and waist tether hooks are shown above.

OPERATIONAL COMMENTS

The large and small universal hooks incorporate a lock-lock feature which requires the crewmember to press two actuation buttons located on opposite sides of the bail. The buttons are pressed simultaneously which compresses the male and female plungers and releases the hook from its locked position. The hook can then be attached to or released from a tether point.

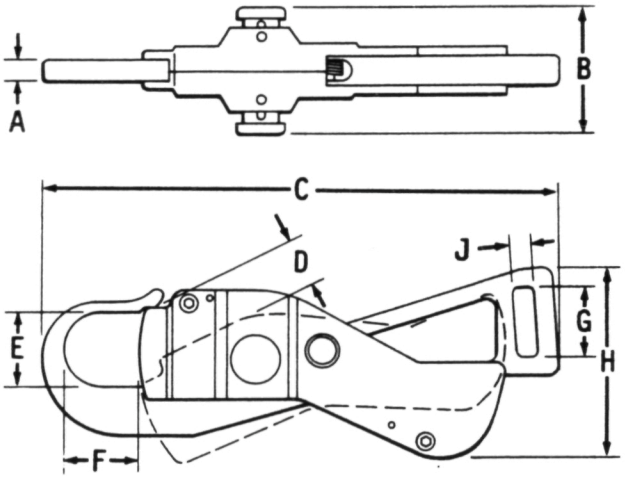
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

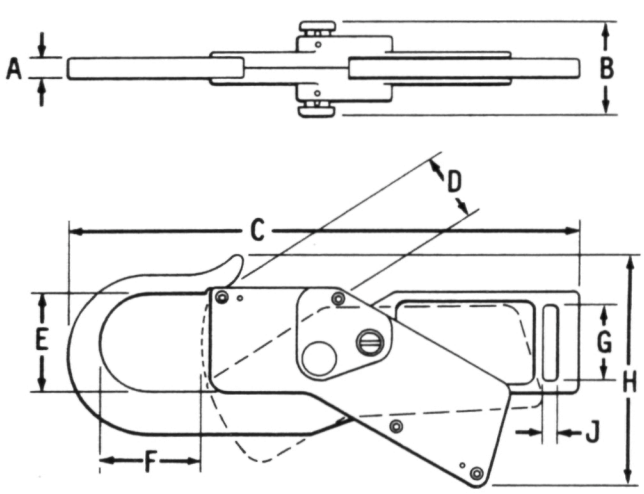
HOOK, UNIVERSAL TETHER

Technical Information		
Part number	10181-10046-01 10181-10047-01 9792-01 10151-20083-01	(small) (large) (small) (large)
Weight	Small Large	0.22 lb 0.50 lb
Material/ construction	Aluminum alloy	
Temperature Range	-150° to +250° F	
Availability	Flight specific	

Dimensional Data		
	10181-10046-01	10181-10047-01
A	0.20 in.	0.30 in.
B	1.31 in.	1.40 in.
C	5.25 in.	7.50 in.
D	0.60 in.	1.00 in.
E	0.80 in.	1.50 in.
F	0.80 in.	1.50 in.
G	0.75 in.	1.10 in.
H	2.00 in.	4.20 in.
J	0.20 in.	0.25 in.



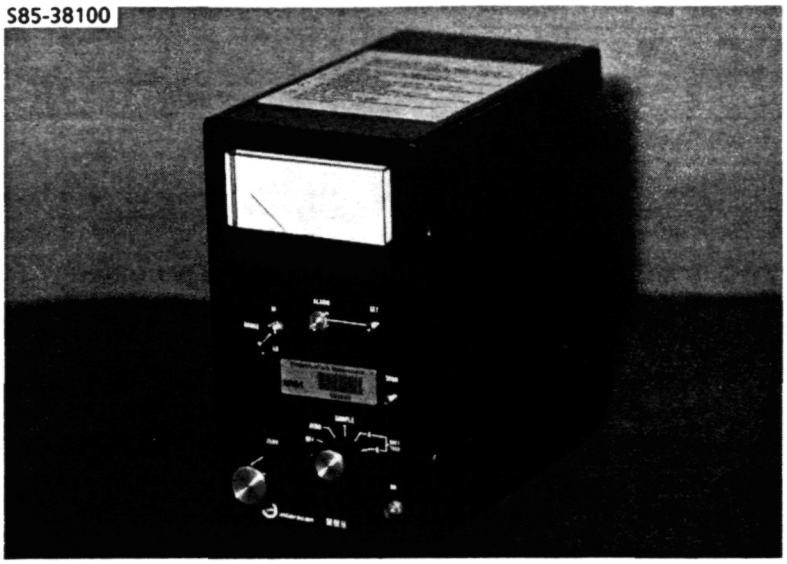
10181-10046-01



10181-10047-01

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

HYDRAZINE ANALYZER



OVERVIEW

The hydrazine analyzer (referred to as Interscan) is an off-the-shelf black box instrument which provides the capability for determining quantitative levels of hydrazine contamination. The Interscan is passed into the airlock to test its atmosphere once it has been repressurized to cabin pressure. If contamination is detected by the Interscan, the EVA crew will return to vacuum and sublimate (bake out) the hydrazine to space.

OPERATIONAL COMMENTS

The Interscan is an electrochemical gas detector which generates a current directly proportional to the hydrazine gas concentration found in the air. This current is converted to a voltage for display on a graduated meter.

The Interscan is intended for use during the post-EVA flight procedures following airlock repress to cabin pressure. Once the Interscan has been configured correctly, it is quickly passed through the airlock inner hatch to the extravehicular (EV) crew. This exchange should not allow any airborne contamination to spill into the middeck since the cabin will be at an equal or up to +0.5-psid pressure relative to the airlock. The EV crew will then direct the gas inlet of the Interscan at suspected contamination areas. If the meter reads less than 1.6 parts per million (PPM), the inner hatch may be opened as long as two hydrazine removal canisters are installed. A greater than 1.6-PPM reading will require that additional cleanup and safety procedures be performed by the EV crew.

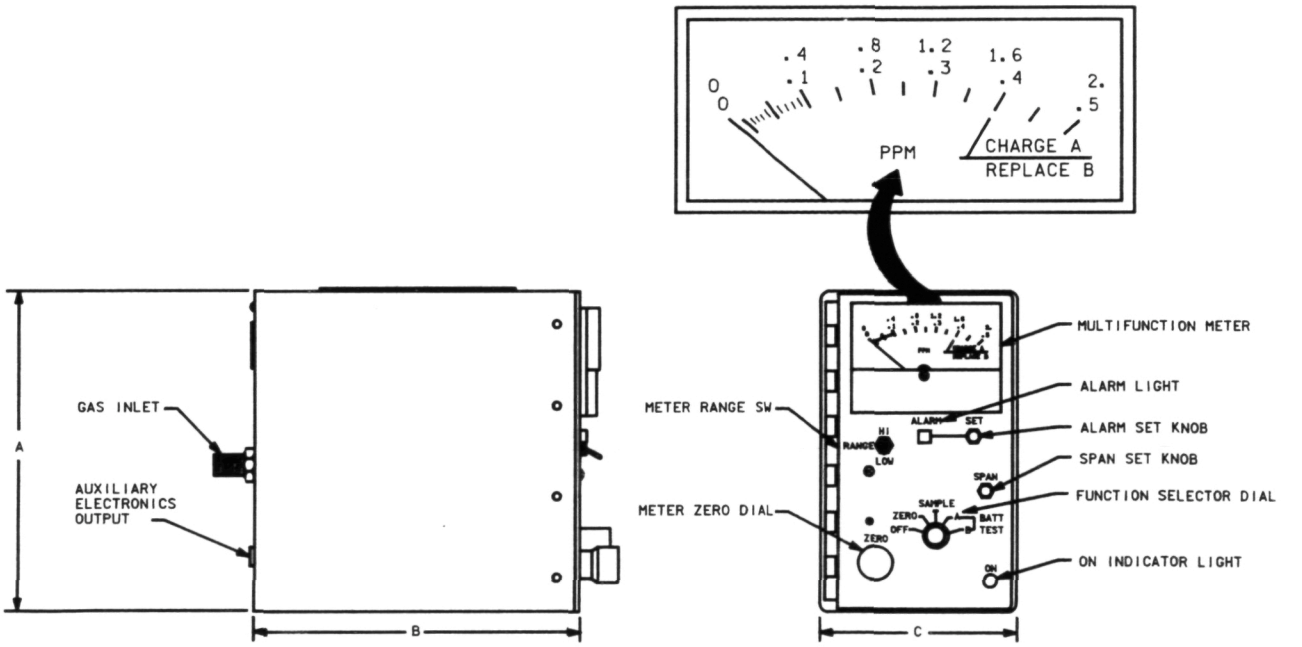
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483-2589
Technical: I. Galen, Krug Int./SD4, (713) 483-7251
Source: Interscan Corporation, (800) 458-6153

HYDRAZINE ANALYZER

Technical Information	
Part number	SED42103121-302
Weight	4.1 lbm
Material	Aluminum case
Battery circuit A	Powered by four rechargeable NiCd batteries. Provides up to 10 hr continuous service (750 mA-h). Supplies power for pump, alarm light, on indicator light
Battery circuit B	Powered by two alkaline MnO2 C-cell batteries. Supplies a constant reference voltage to the gas sensor
Alarm light	Red LED, 600 nm peak wave length
Availability	Flight specific

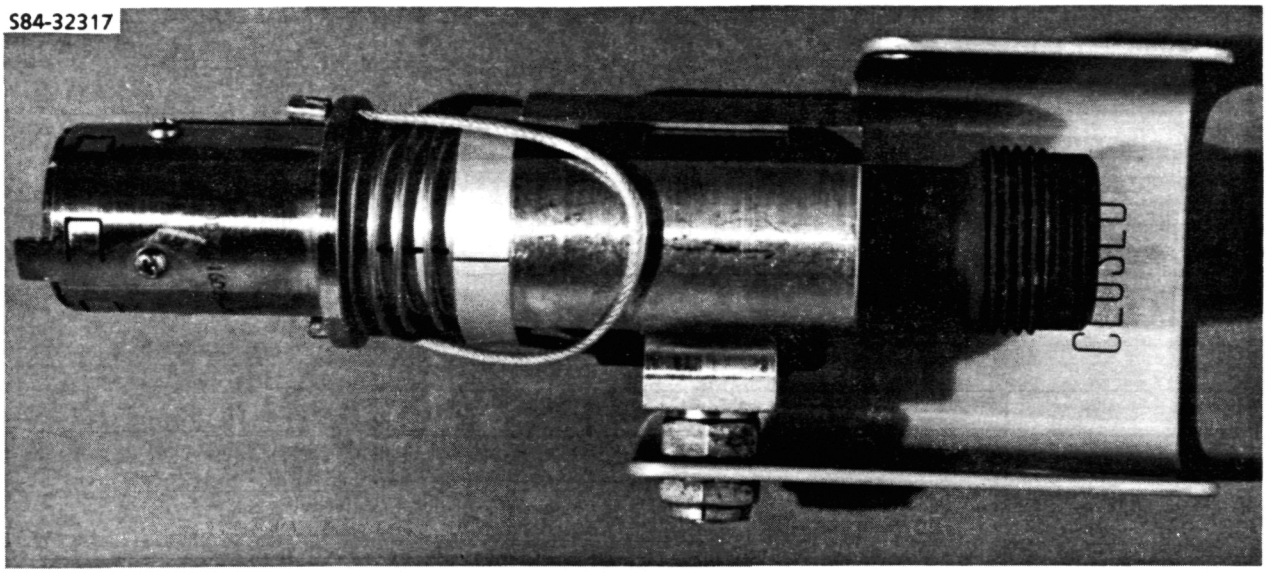
Dimensional Data	
A	7.000 in.
B	8.875 in
C	4.000 in.



205976409.ART; 2

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

HYDRAZINE BALL VALVE HOUSING



OVERVIEW

The hydrazine ball valve housing is part of the hydrazine servicing tool (HST) set. It is a special purpose tool which is used with the HST set and the orbital refueling system (ORS) to refuel on-orbit satellites from the STS. The HST set connects to the fill and drain valve of the orbiting satellite, and a relief valve in the ball valve housing allows pressure bleed-off. A tether ring is attached to the housing.

OPERATIONAL COMMENTS

The ball valve housing screws onto the satellite valve to provide a redundant seal during satellite valve hex nut and seal cap removal and during multipurpose tool installation. The ball valve should be in the closed position when tools are being attached to the housing.

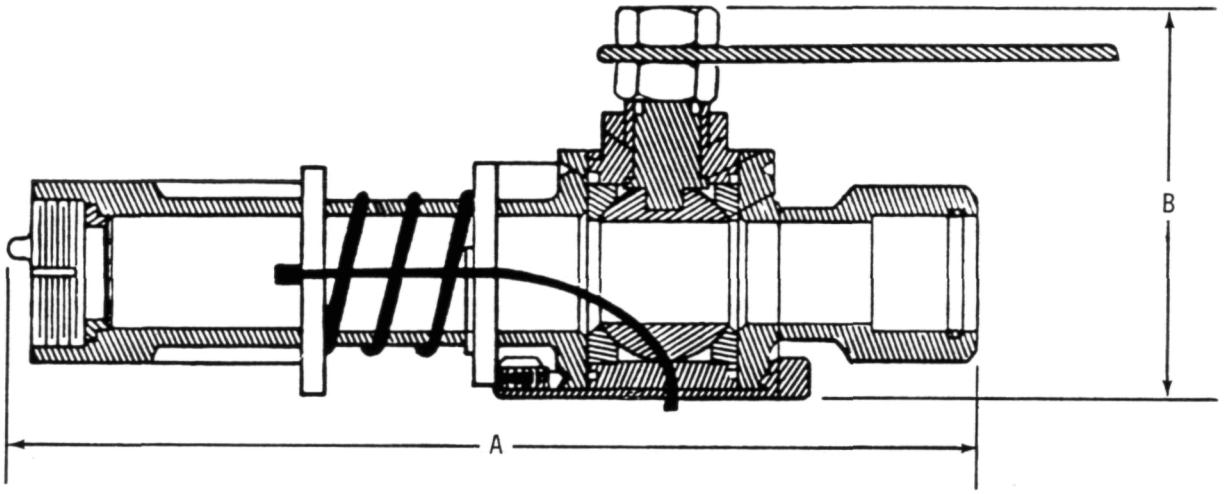
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: T. M. Grubbs, NASA/EC5, (713) 483-9149
Source: T. M. Grubbs, NASA/EC5, (713) 483-9149

HYDRAZINE BALL VALVE HOUSING

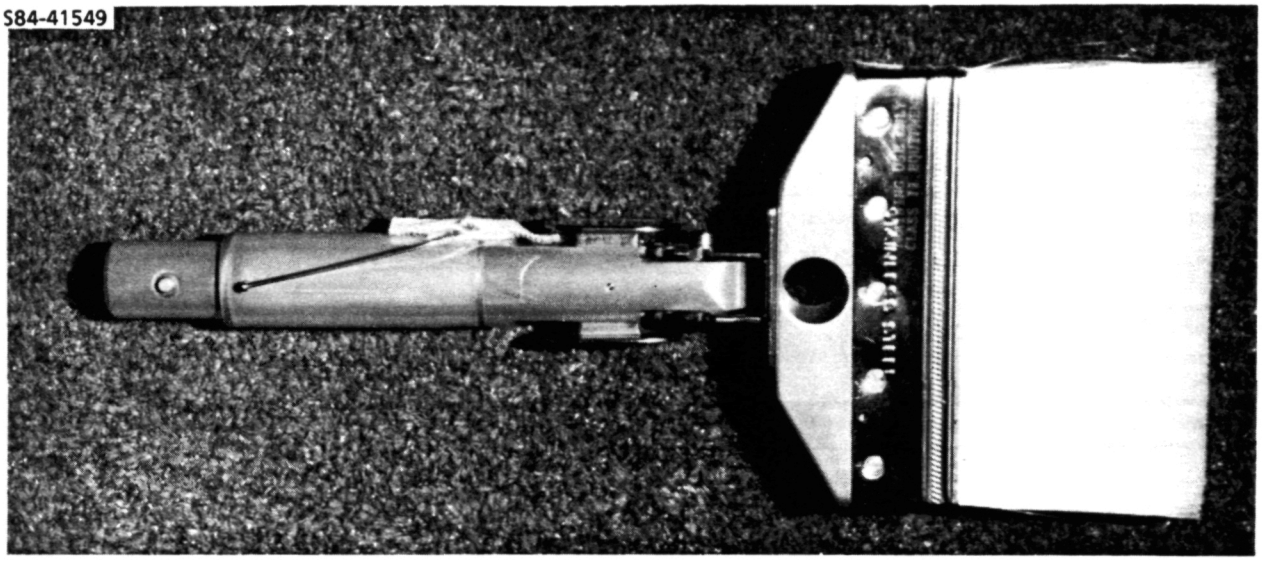
Technical Information	
Part number	SED 39116005
Weight	2.24 lb
Material	Anodized aluminum
Force/torque	Installed ball valve - 150 ± 50 in-lb maximum
Design temperature range	35° to 120° F
Marking	7/16-in. black letters on gold handle: OPEN, CLOSED
Availability	Flight specific

Dimensional Data	
A	8.7500 in.
B	3.4375 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

HYDRAZINE BRUSH



OVERVIEW

The hydrazine brush is manifested when there is a possibility of extravehicular mobility unit (EMU) contamination by payload-related hydrazine. The brush is used in the cargo bay to remove visible hydrazine contamination from the EMU. The brush is a modified Apollo lunar dust brush. Squeezing two knobs on the base of the handle allows the handle to be rotated, which changes the brush orientation. A tether ring is attached to the handle.

OPERATIONAL COMMENTS

Hydrazine can be detected on the EMU as flakes (white snow color), as ice (white patches), or as stains (light brown). The crew will inspect each other when clear of a potential contamination source and use the hydrazine brush to remove any flakes prior to entering the airlock. Stowage for the brush is provided in the port provisions stowage assembly (PSA) on a flight-specific basis.

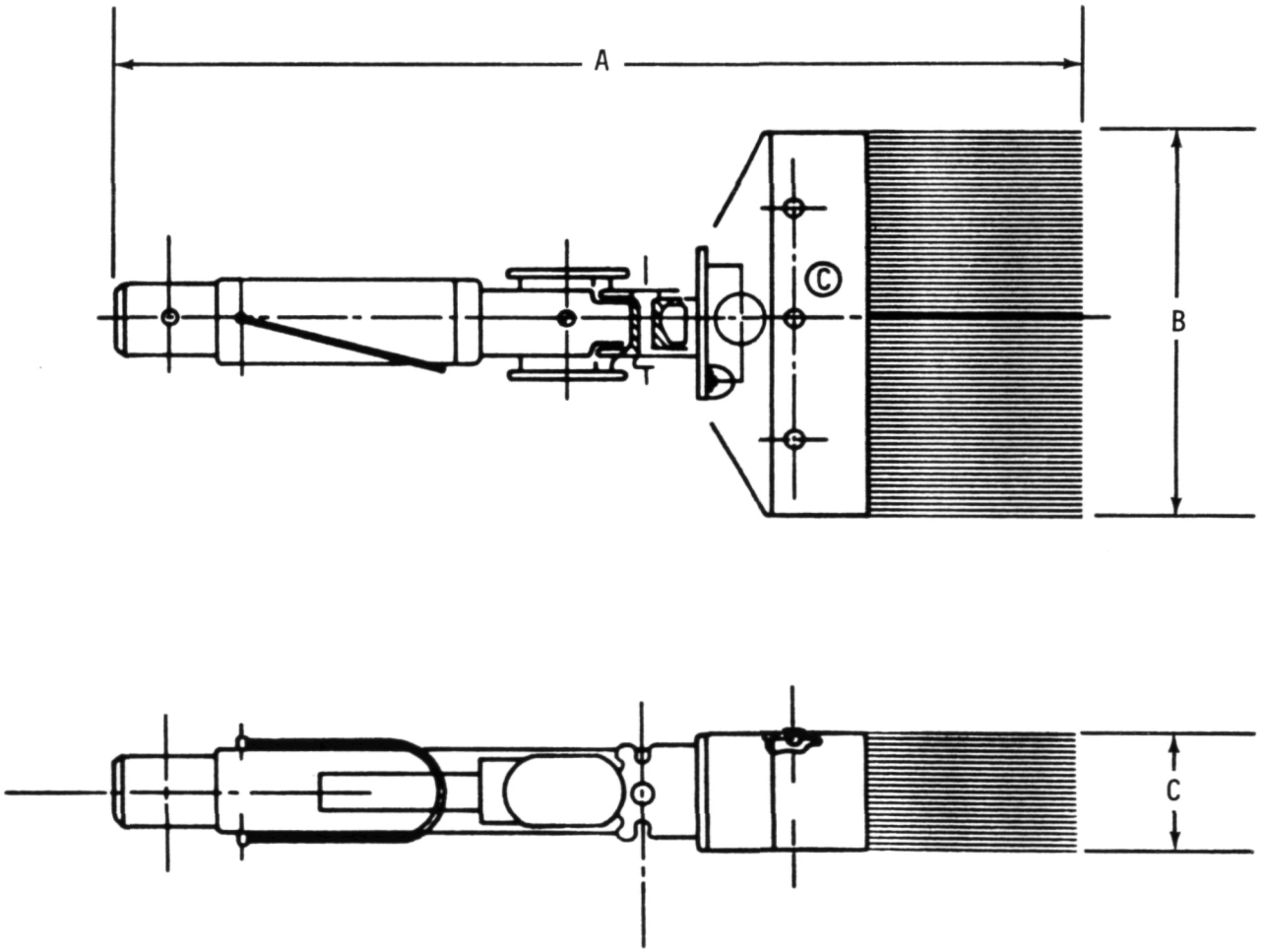
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483-2589
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: R. J. Marak, NASA/EC5, (713) 483-9144

HYDRAZINE BRUSH

Technical Information	
Part number	SEB 39115185-301
Weight	1.4 lb
Material	Stainless steel and anodized aluminum handle
Force/torque	150 ± 50 in-lb maximum
Temperature range	-200° to 250° F (operational)
Handle rotation	Locks at 0°, ±45°, ±90°
Availability	Flight specific

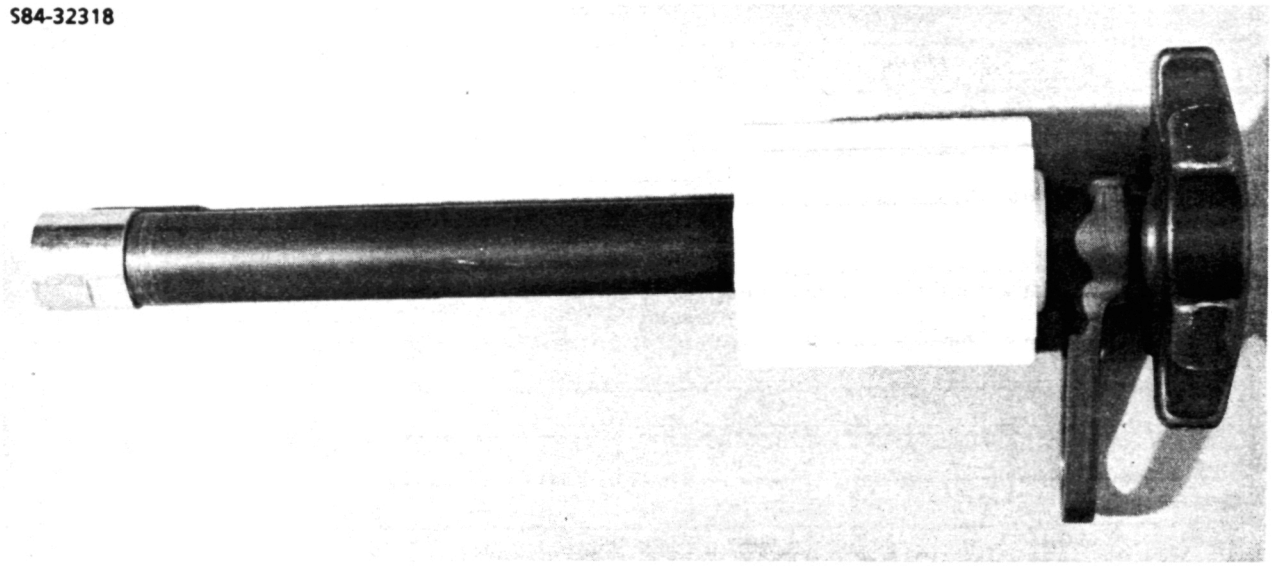
Dimensional Data	
A	12.5 in.
B	5.0 in.
C	1.5 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

HYDRAZINE CAP RETAINER ASSEMBLY

S84-32318



OVERVIEW

The hydrazine cap retainer assembly is part of the hydrazine servicing tool (HST) set. It is a special-purpose tool which is used with the HST set and the orbital refueling system (ORS) to refuel on-orbit satellites from the STS. The HST set connects to the fill and drain valve of the orbiting satellite. There is a plug on one end to remove the hydrazine cap and a mushroom handle on the other end. A sliding silver knob and tether ring are mounted on the tool shaft.

OPERATIONAL COMMENTS

The hydrazine cap retainer assembly is used to remove the cap from the satellite fill and drain valve. The tool is inserted into the ball valve housing and the silver knob is rotated clockwise until hand-tight. The ball valve is opened, the mushroom handle is depressed to capture the cap, the tool is retrieved clear of the ball valve, the valve is closed, and the tool with the hydrazine cap is removed.

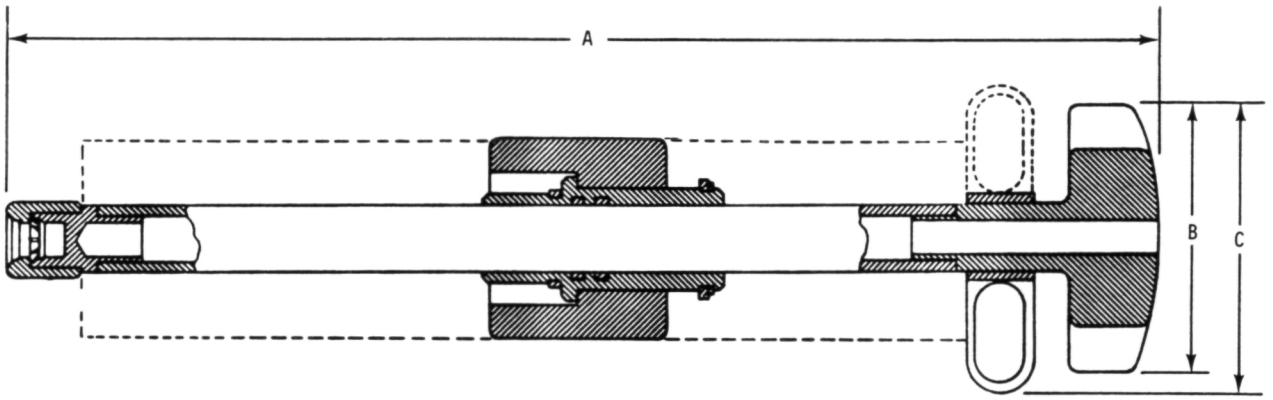
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: T. M. Grubbs, NASA/EC5, (713) 483-9149
Source: T. M. Grubbs, NASA/EC5, (713) 483-9149

HYDRAZINE CAP RETAINER ASSEMBLY

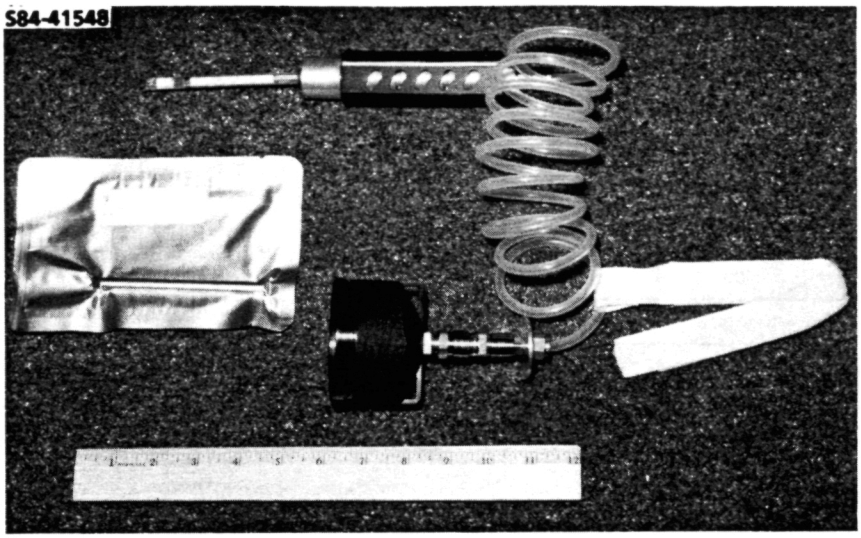
Technical Information	
Part number	SED 39115758
Weight	1.0 lb
Material	Anodized aluminum
Force/torque	Silver knob - 150 ± 50 in-lb maximum
Design temperature range	35° to 150° F
Marking	Color coding - knob, silver Decals - on launch cover, 1/4-in. black letters on silver: SEAL
Availability	Flight specific

Dimensional Data	
A	13.10 in.
B	3.00 in.
C	3.25 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

HYDRAZINE DETECTOR



OVERVIEW

The hydrazine detector is intended to be only a qualitative sampler of hydrazine contamination. The detector kit consists of two parts, the air sampler and the detector tube. The air sampler consists of an airlock depress valve cap, a tube holder, and coiled Teflon tubing. The detector tubes are covered with Teflon shrink tubing and are packaged in standard foil-Mylar vacuum packaging.

Detection is based upon the chemical reaction of hydrazine with a crystalline mixture of yellow acetic acid and bromophenol blue. Reaction occurs as the airlock atmosphere is drawn through the reactants. The crystals change color from yellow to blue upon contact with hydrazine.

OPERATIONAL COMMENTS

The system is stowed in the airlock EVA bag prior to depress and is assembled by the EVA crew for use after airlock repress to cabin pressure. Operation and contamination detection involve a 20- to 30-second depress of the airlock with visual observation of a color change in the detector. If hydrazine is detected, the EVA crew will return to vacuum to sublimate any contamination. This system is also known as the Draeger tube in crew procedures.

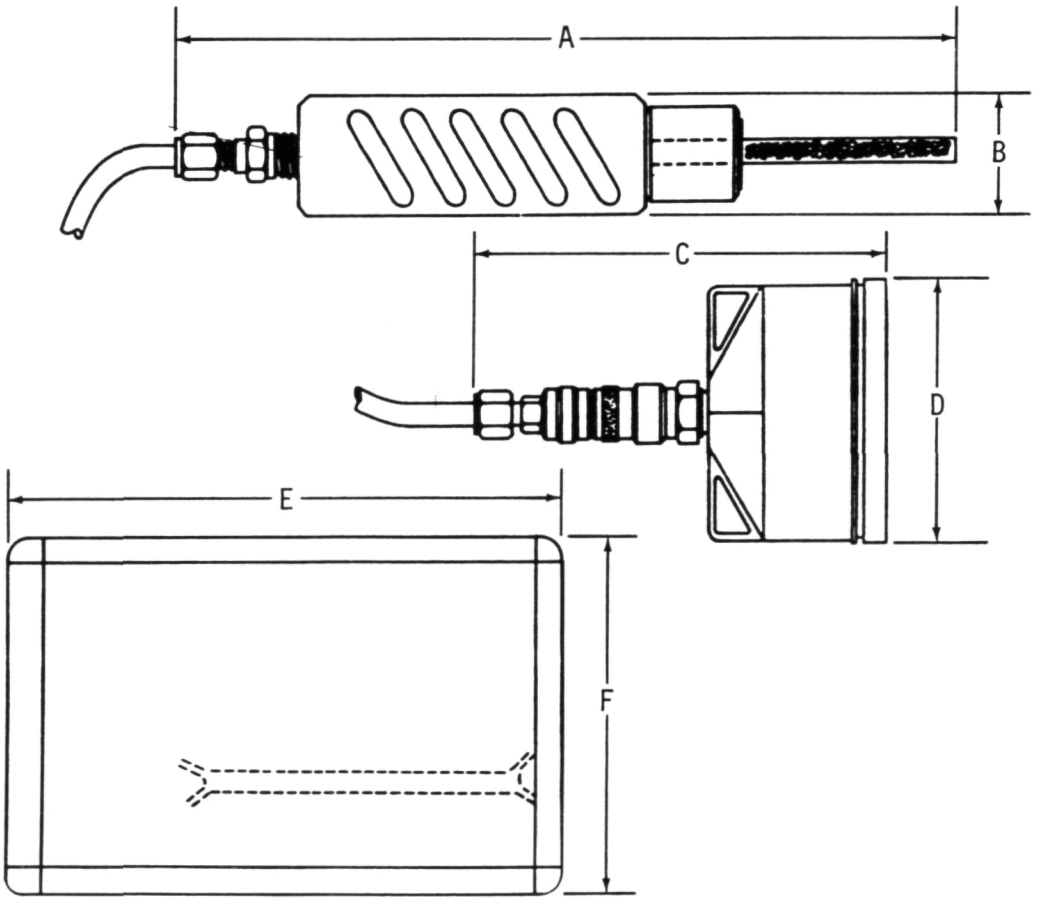
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483-2589
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: R. J. Marak, NASA/EC5, (713) 483-9144

HYDRAZINE DETECTOR

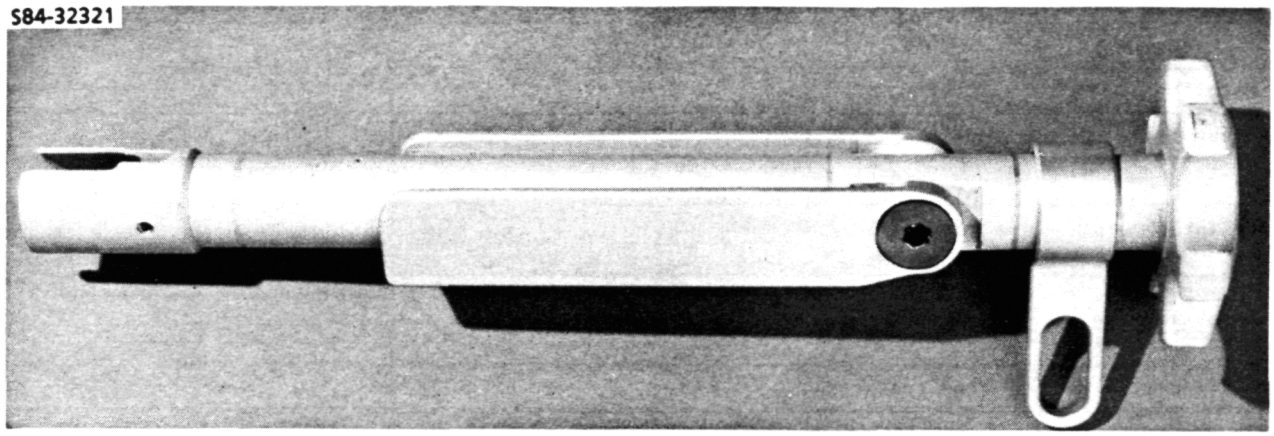
Technical Information	
Part number	SED 39116311-301 (air sampler) SED 39117159-301 (Draeger tube)
Weight	1.3 lb
Material	Package - foil-Mylar Tubing - Teflon Tube holder - anodized aluminum Valve cap - anodized aluminum Draeger tube - glass covered by Teflon shrink tubing
Force/torque	Attach cap to depress valve - hand-tight
Design temperature range	50° to 122° F
Accuracy	Qualitative only
Availability	Flight specific

Dimensional Data	
A	9.750 in.
B	1.500 in.
C	5.250 in.
D	3.125 in.
E	6.875 in.
F	4.250 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

HYDRAZINE DUST CAP REMOVER



OVERVIEW

The hydrazine dust cap remover is part of the hydrazine servicing tool (HST) set. It is a special purpose tool which is used with the HST set and the orbital refueling system (ORS) to refuel on-orbit satellites from the STS. The HST set connects to the fill and drain valve of the orbiting satellite. There is a claw on one end to remove the dust caps and a mushroom handle on the other end. A swivel arm and tether ring are attached to the tool shaft.

OPERATIONAL COMMENTS

The hydrazine dust cap remover is used to remove the dust caps from the satellite fill and drain valve. The tool is installed on the top left satellite valve by slipping the tool over the dust cap and rotating until the claw is engaged with the ridge on the dust cap. The dust cap is unscrewed and removed.

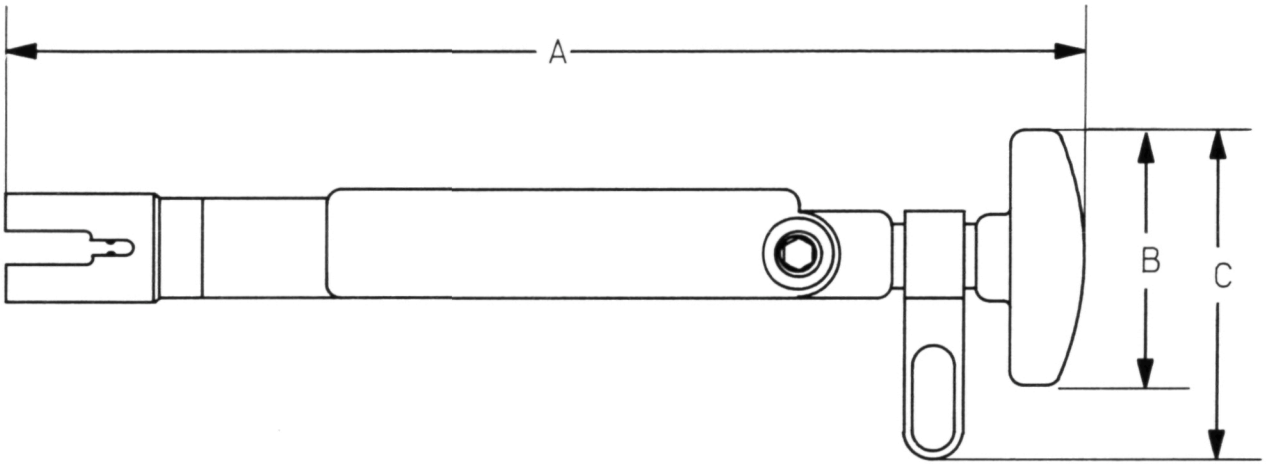
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: T. M. Grubbs, NASA/EC5, (713) 483-9149
Source: T. M. Grubbs, NASA/EC5, (713) 483-9149

HYDRAZINE DUST CAP REMOVER

Technical Information	
Part number	SED 39116110
Weight	1.0 lb
Material	Anodized aluminum
Force/torque	150 ± 50 in-lb maximum
Design temperature range	35° to 150° F
Availability	Flight specific

Dimensional Data	
A	12.5 in.
B	3.0 in.
C	3.9 in.

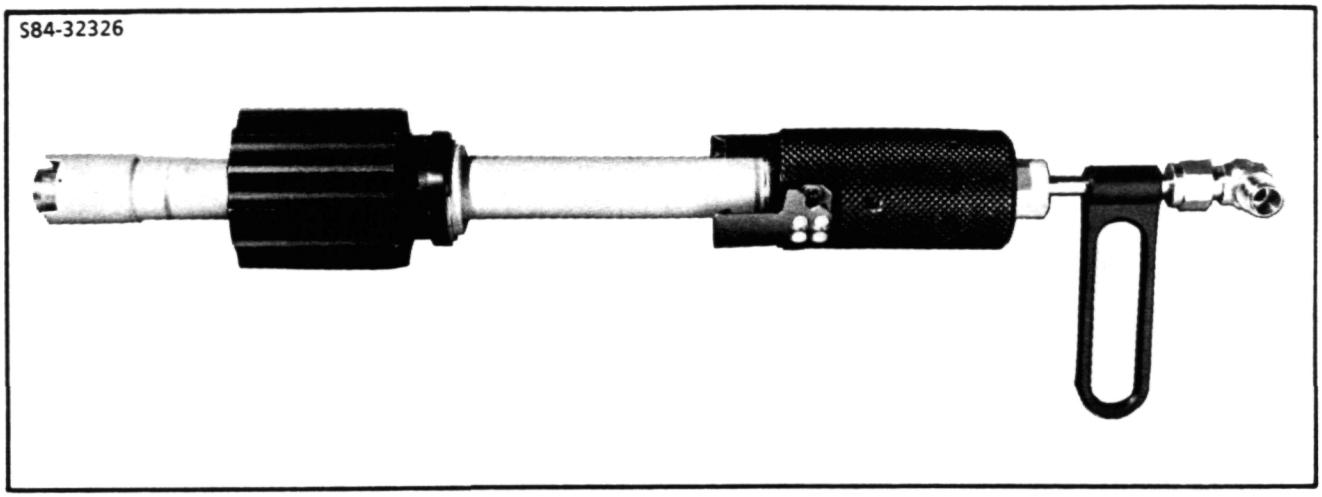


204660071.ART, 3

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

HYDRAZINE MULTIPURPOSE TOOL

S84-32326



OVERVIEW

The hydrazine multipurpose tool is part of the hydrazine servicing tool (HST) set. It is a special-purpose tool which is used with the HST set and the orbital refueling system (ORS) to refuel on-orbit satellites from the STS. The HST set connects to the fill and drain valve of the orbiting satellite. The tool is attached by a flexline to the ORS service line prior to launch. A B-nut is on one end of the tool, and the flexline is on the other. Two knobs (one large blue and one small green) and a tether ring are mounted on the tool shaft.

OPERATIONAL COMMENTS

The hydrazine multipurpose tool is used to transfer hydrazine from the ORS to the satellite. The tool is attached to the ball valve housing by rotating the large blue knob clockwise. The ball valve is opened, and the small green knob is rotated clockwise until the B-nut is seated on the valve fitting.

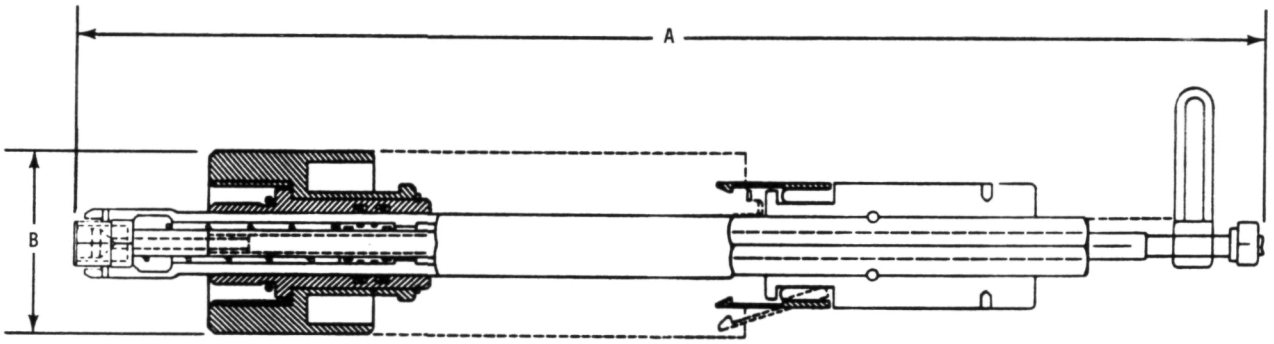
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: T. M. Grubbs, NASA/EC5, (713) 483-9149
Source: T. M. Grubbs, NASA/EC5, (713) 483-9149

HYDRAZINE MULTIPURPOSE TOOL

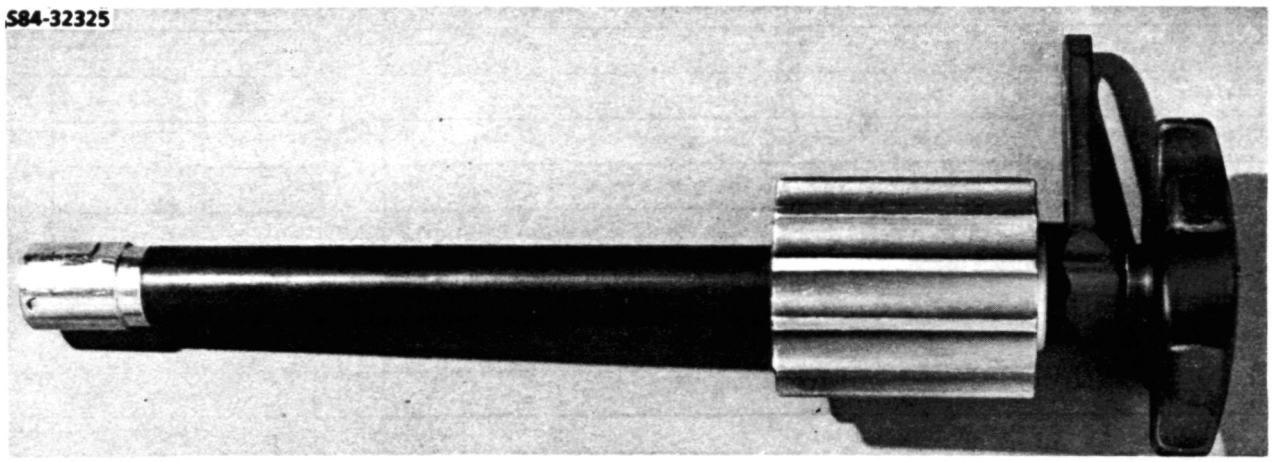
Technical Information	
Part number	SED 39115847
Weight	1.7 lb
Material	Anodized aluminum
Force/torque	Large blue knob - 105 ± 5 in-lb Small green knob - 150 ± 5 in-lb maximum
Design temperature range	35° to 150° F
Color coding	Small knob - green Large knob - blue Operator clips - red
Availability	Flight specific

Dimensional Data	
A	14.2 in.
B	4.5 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

HYDRAZINE NUT RETAINER ASSEMBLY



OVERVIEW

The hydrazine nut retainer assembly is part of the hydrazine servicing tool (HST) set. It is a special-purpose tool which is used with the HST set and the orbital refueling system (ORS) to refuel on-orbit satellites from the STS. The HST set connects to the fill and drain valve of the orbiting satellite. This tool has a friction collar on one end and a mushroom handle on the other end. A sliding red knob and tether ring are mounted on the tool shaft.

OPERATIONAL COMMENTS

The hydrazine nut retrieval tool is used to remove the hex nut from the satellite fill and drain valve. The tool is inserted into the ball valve housing, and the red knob is rotated clockwise until hand-tight. The ball valve is opened, the friction collar is depressed on the hex nut, the nut is unscrewed, the tool is retrieved clear of the ball valve, the valve is closed, and the tool with the hex nut is removed.

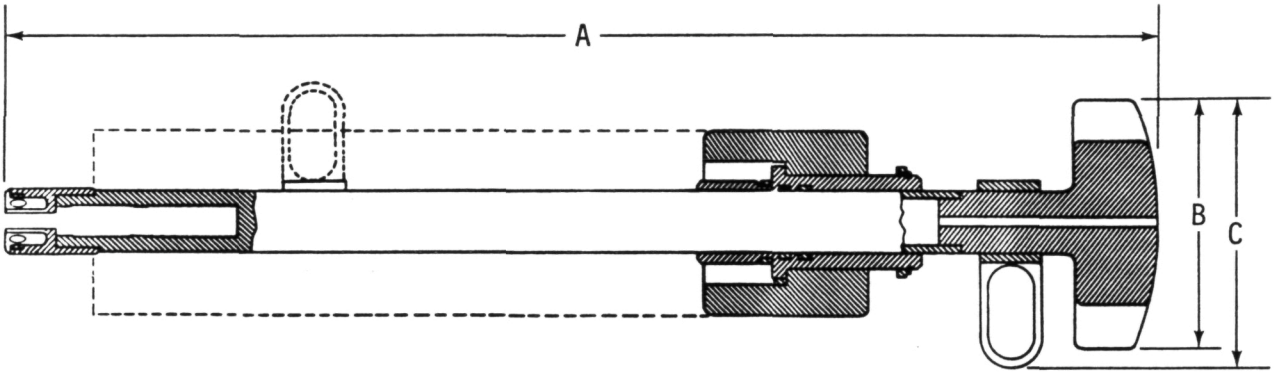
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: T. M. Grubbs, NASA/EC5, (713) 483-9149
Source: T. M. Grubbs, NASA/EC5, (713) 483-9149

HYDRAZINE NUT RETAINER ASSEMBLY

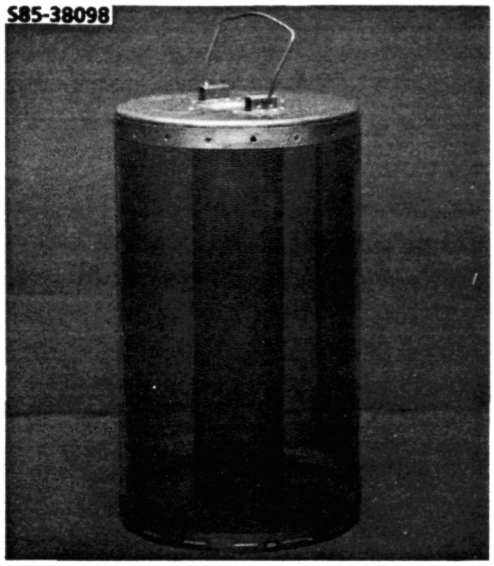
Technical Information	
Part number	SED 39115766
Weight	1.1 lb
Material	Anodized aluminum
Force/torque	Red knob - 150 ± 50 in-lb maximum
Design temperature range	35° to 150° F
Color coding	Knob - red
Availability	Flight specific

Dimensional Data	
A	10.75 in.
B	3.00 in.
C	3.25 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

HYDRAZINE REMOVAL CANISTER



OVERVIEW

The Orbiter atmosphere revitalization system nominally scrubs CO_2 out of the cabin air through two LiOH canisters installed in the middeck floor. On missions in which EVA hydrazine contamination is a possibility, two hydrazine removal canisters are also manifested. While the LiOH canisters will eventually remove hydrazine from the cabin, the hydrazine canisters are two to three times faster because they contain an ambient temperature catalytic oxidizer (ATCO). Both canisters are externally identical except that the LiOH canister top is gold and the ATCO canister top is white.

OPERATIONAL COMMENTS

These canisters are used in conjunction with the hydrazine analyzer and hydrazine detector during post-EVA procedures for hydrazine contamination. If hydrazine contamination is detected in the cabin, both LiOH canisters should be replaced with the two hydrazine canisters. These special canisters may remain in place for 2 hours or until cabin $PPCO_2$ reaches 7 to 10 mm Hg. At that time, one new LiOH canister will be reinstalled. This configuration will be maintained until the cabin is clean. Any remaining hydrazine will eventually oxidize after several hours.

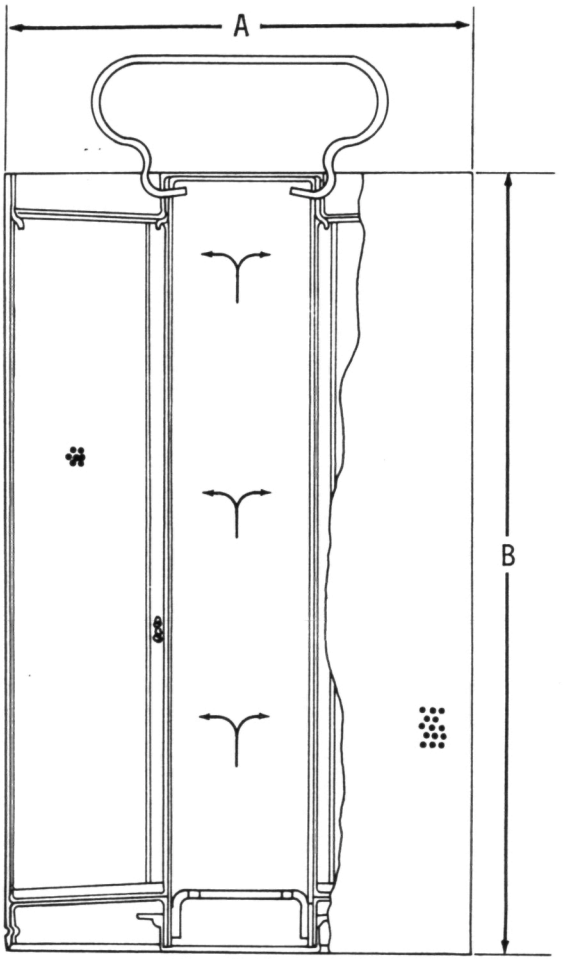
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483-2589
Technical: G. Winkler, NASA/EC6, (713) 483-9244
Source: Rockwell International

HYDRAZINE REMOVAL CANISTER

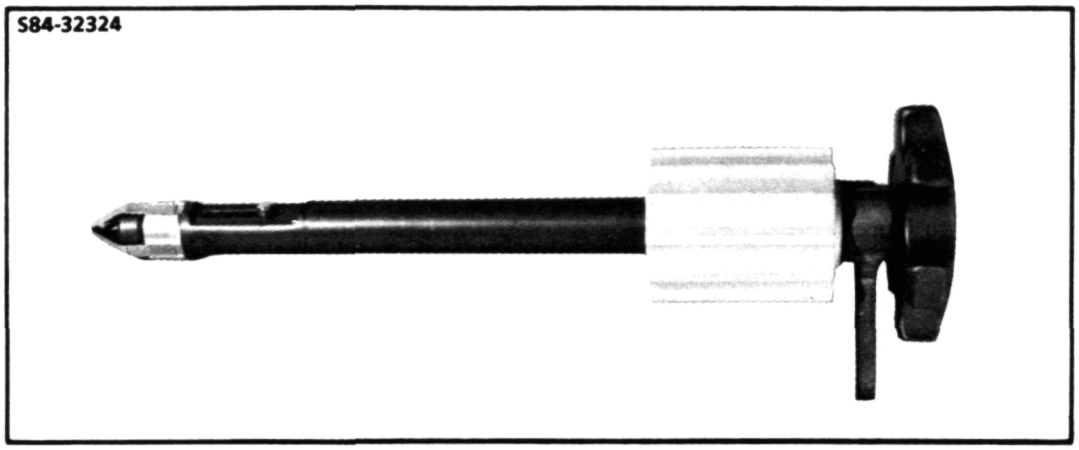
Technical Information	
Part number	MC 621-0008-0060
Weight	6.72 lb
Quantity flown	Two for STS 41G, STS 51A and STS 51I
Availability	Flight specific

Dimensional Data	
A	6.68 in.
B	11.30 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

HYDRAZINE RETRIEVAL TOOL



OVERVIEW

The hydrazine retrieval tool is part of the hydrazine servicing tool (HST) set. It is a special purpose tool which is used with the HST set and the orbital refueling system (ORS) to refuel on-orbit satellites from the STS. The HST set connects to the fill and drain valve of the orbiting satellite. This tool has a grapple plunger on one end and a mushroom handle on the other end. A silver knob and a tether ring are mounted on the tool shaft.

OPERATIONAL COMMENTS

The hydrazine retrieval tool is used to remove the hex nut from the satellite fill and drain valve if the nut does not come out with the hydrazine nut retrieval tool. The tool is inserted into the ball valve housing, and the silver knob is rotated clockwise until hand-tight. The ball valve is opened, the grapple plunger is depressed onto the hex nut, the tool is retrieved clear of the ball valve, the valve is closed, and the tool with the hex nut is removed.

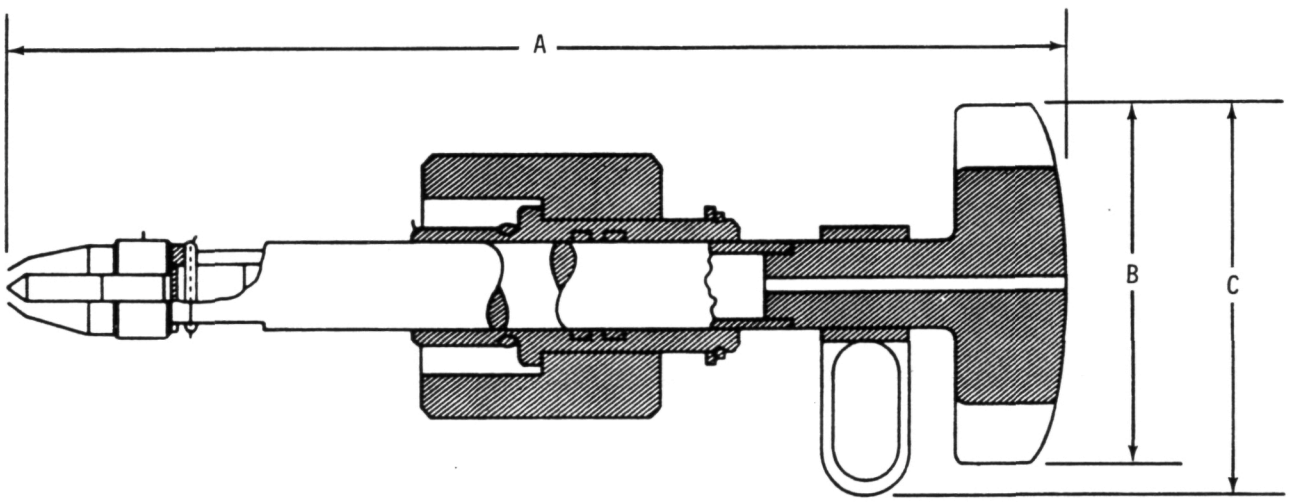
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: T. M. Grubbs, NASA/EC5, (713) 483-9149
Source: T. M. Grubbs, NASA/EC5, (713) 483-9149

HYDRAZINE RETRIEVAL TOOL

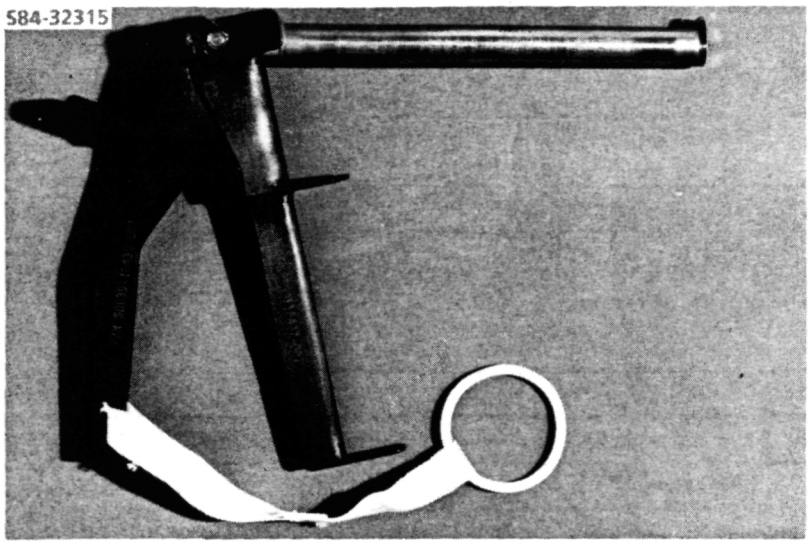
Technical Information	
Part number	SED 39115865
Weight	1.06 lb
Material	Anodized aluminum
Force/torque	Silver knob - 150 ± 50 in-lb maximum
Design temperature range	35° to 150° F
Markings	On launch cover, 1/4-in. black letters on silver: GRAPPLE
Color coding	Knob - silver
Availability	Flight specific

Dimensional Data	
A	10.75 in.
B	3.00 in.
C	3.25 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

HYDRAZINE RIGHT ANGLE CLIPPER



OVERVIEW

The hydrazine right angle clipper is part of the hydrazine servicing tool (HST) set. It is a special-purpose tool which is used with the HST set and the orbital refueling system (ORS) to refuel on-orbit satellites from the STS. The HST set connects to the fill and drain valve of the orbiting satellite. The clipper is a pistol-grip type of tool with a knife opening movement on the top end of the barrel and a squeeze trigger handle. A tether ring is attached to the handle.

OPERATIONAL COMMENTS

The hydrazine right angle clipper is used to cut the satellite valve dust cap lockwire away from the satellite valve.

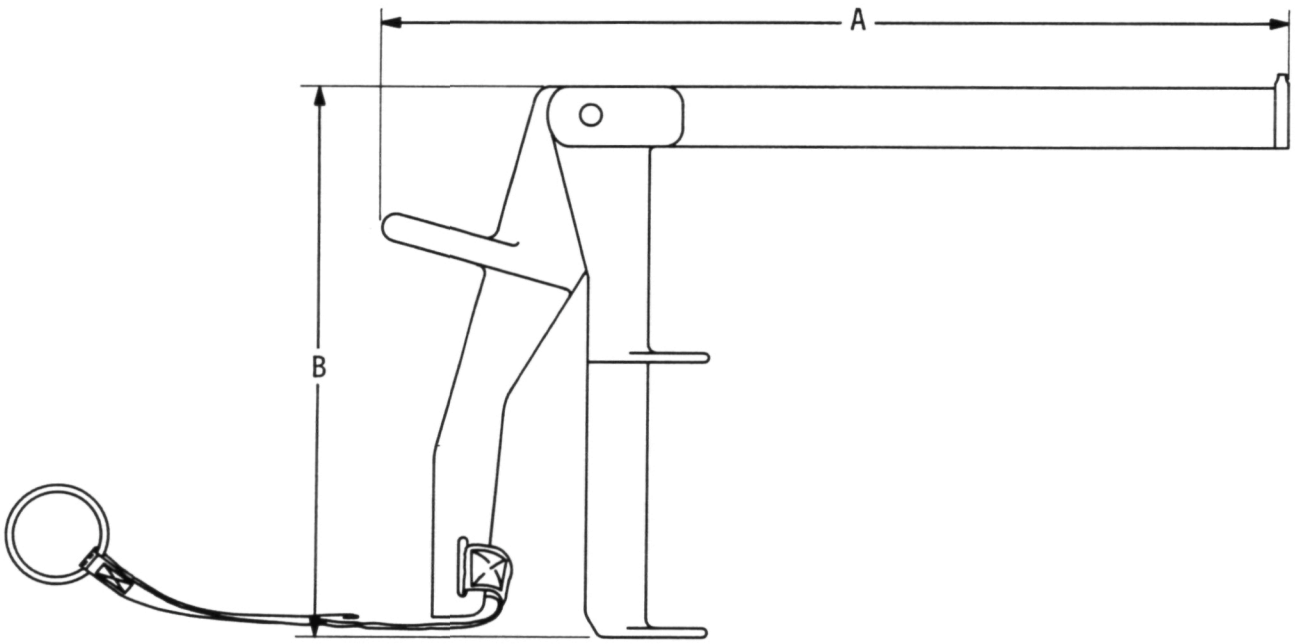
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: T. M. Grubbs, NASA/EC5, (713) 483-9149
Source: T. M. Grubbs, NASA/EC5, (713) 483-9149

HYDRAZINE RIGHT ANGLE CLIPPER

Technical Information	
Part number	SDD 39116430-001
Weight	0.44 lb
Material	Handle and barrel - anodized aluminum Knife blades - hardened steel
Force/torque	Close trigger handle - 66.5 lb maximum
Cutting jaw opening	15°, 1/16 by 1/8 in.
Design temperature range	35° to 150° F
Availability	Flight specific

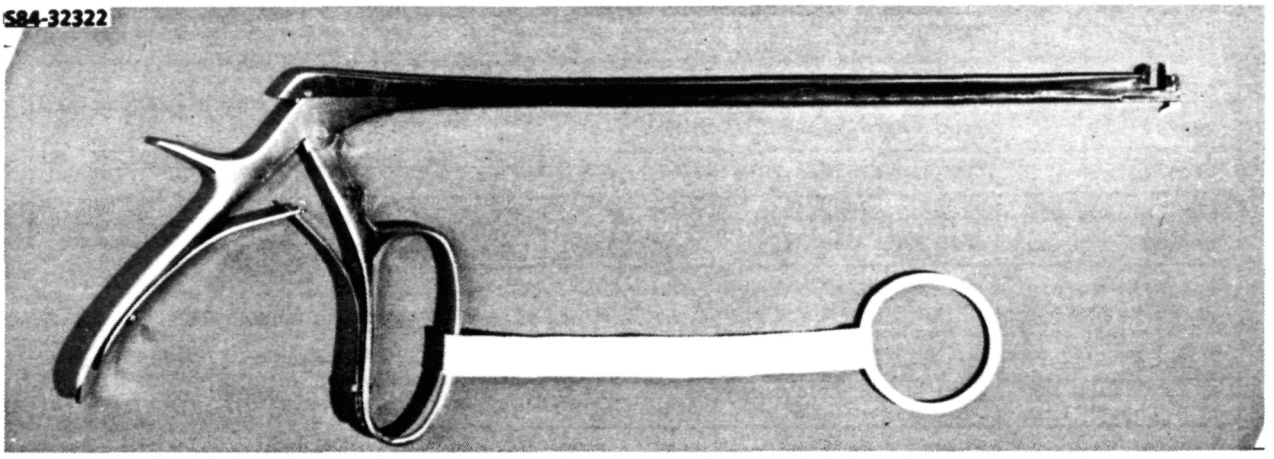
Dimensional Data	
A	7.81 in.
B	4.75 in.



204660075. ART, 3

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

HYDRAZINE SAFETY WIRE CLIPPER



OVERVIEW

The hydrazine safety wire clipper is part of the hydrazine servicing tool (HST) set. It is a special-purpose tool which is used with the HST set and the orbital refueling system (ORS) to refuel on-orbit satellites from the STS. The HST set connects to the fill and drain valve of the orbiting satellite. The clipper is a pistol-grip type of tool with a squeeze trigger handle and a knife opening movement on the top end of the barrel. A tether ring is attached to the trigger.

OPERATIONAL COMMENTS

The hydrazine safety wire clipper is used to cut the top left satellite valve dust cap lockwire away from the satellite valve.

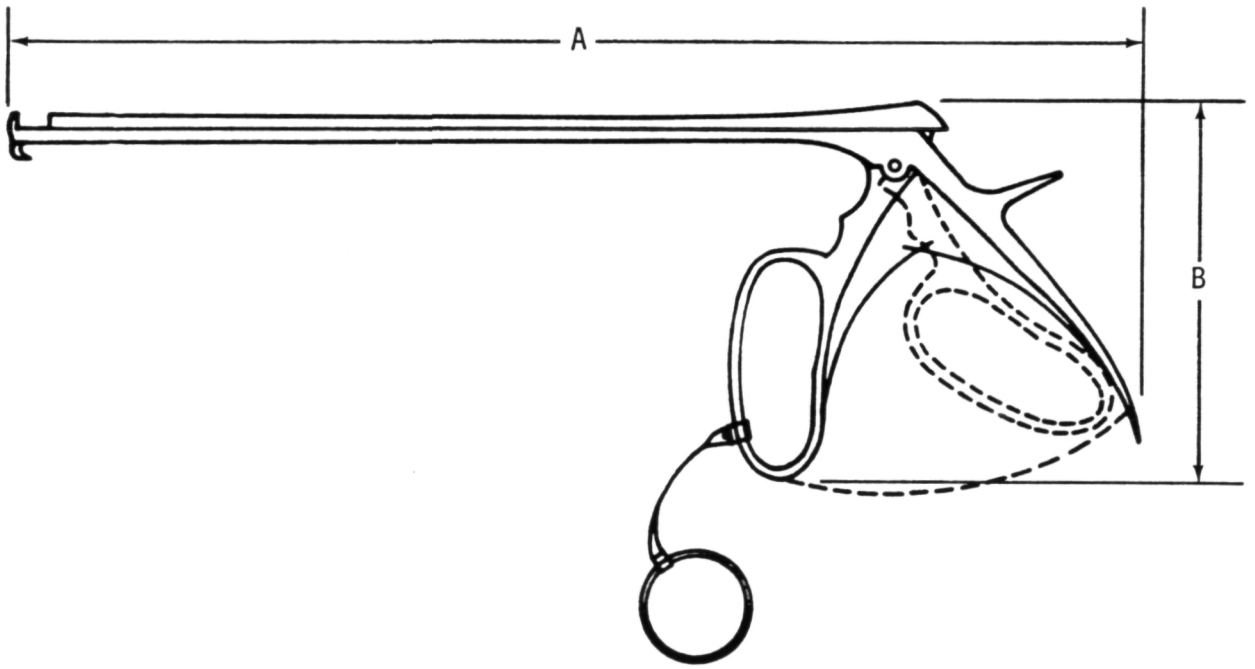
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: T. M. Grubbs, NASA/EC5, (713) 483-9149
Source: T. M. Grubbs, NASA/EC5, (713) 483-9149

HYDRAZINE SAFETY WIRE CLIPPER

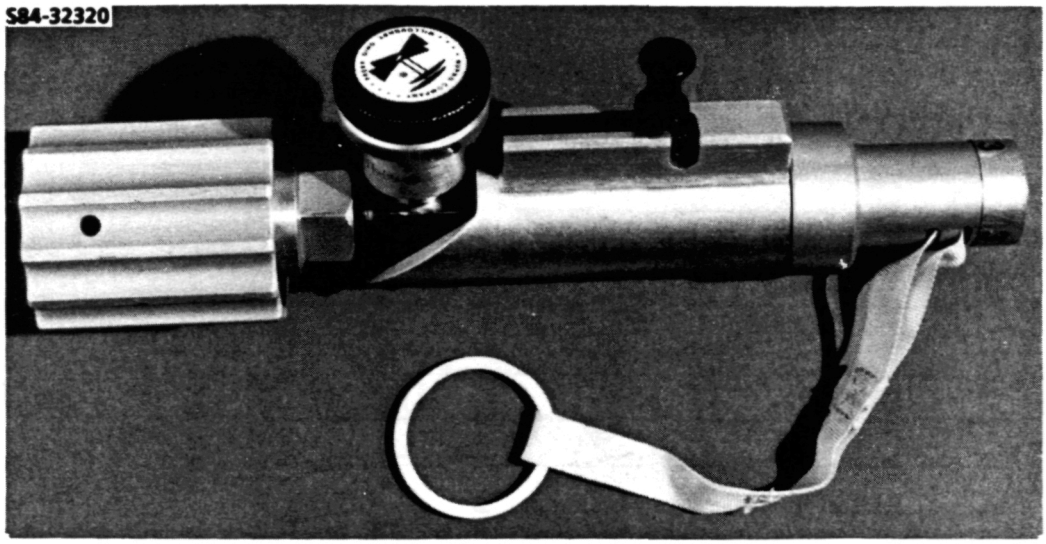
Technical Information	
Part number	SED 39115859
Weight	0.42 lb
Material	Handle and barrel - stainless steel
Force/torque	Squeeze clipper handle - 66.5 lb maximum
Cutting edge opening	5/16 in. high 3/16 in. opening
Design temperature range	35° to 150° F
Availability	Flight specific

Dimensional Data	
A	13.4 in.
B	4.5 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

HYDRAZINE SEAL VERIFICATION TOOL



OVERVIEW

The hydrazine seal verification tool is part of the hydrazine servicing tool (HST) set. The tool is a pressurized gas-containing assembly which provides a leak check capability to ensure correct installation of the ball valve housing. The tool has a silver knob on one end, a green seal valve knob mounted perpendicular to the tool housing, and a Bourdon tube pressure gauge on the other end. The tool is launched with a protective cover and tether ring.

OPERATIONAL COMMENTS

The hydrazine seal verification tool is installed on the ball valve by inserting and rotating the silver knob clockwise (hand-tight) and rotating the green seal valve knob counterclockwise. Verify seal tool cavity pressure (600 to 800 psia). Check pressure decay for leak. Two of these tools are flown with the HST set.

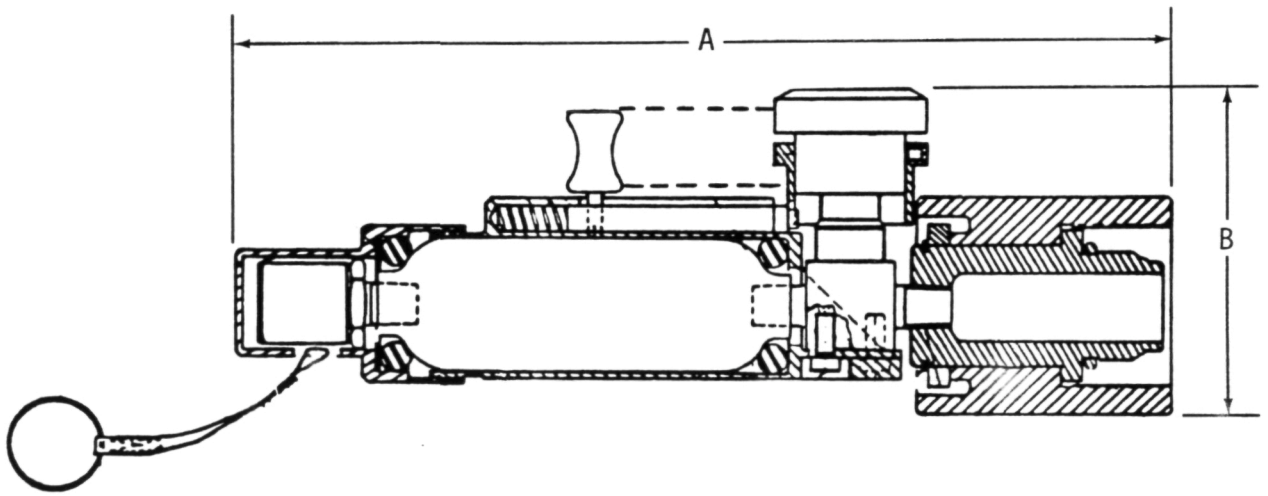
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: T. M. Grubbs, NASA/EC5, (713) 483-9149
Source: T. M. Grubbs, NASA/EC5, (713) 483-9149

HYDRAZINE SEAL VERIFICATION TOOL

Technical Information	
Part number	SED 39116439
Weight	1.32 lb
Material	Anodized aluminum
Force/torque	Silver knob - 150 ± 50 in-lb maximum
Color coding	Seal valve lock - blue Seal valve knob - green Large knob - silver
Design temperature range	35° to 150° F
Availability	Flight specific

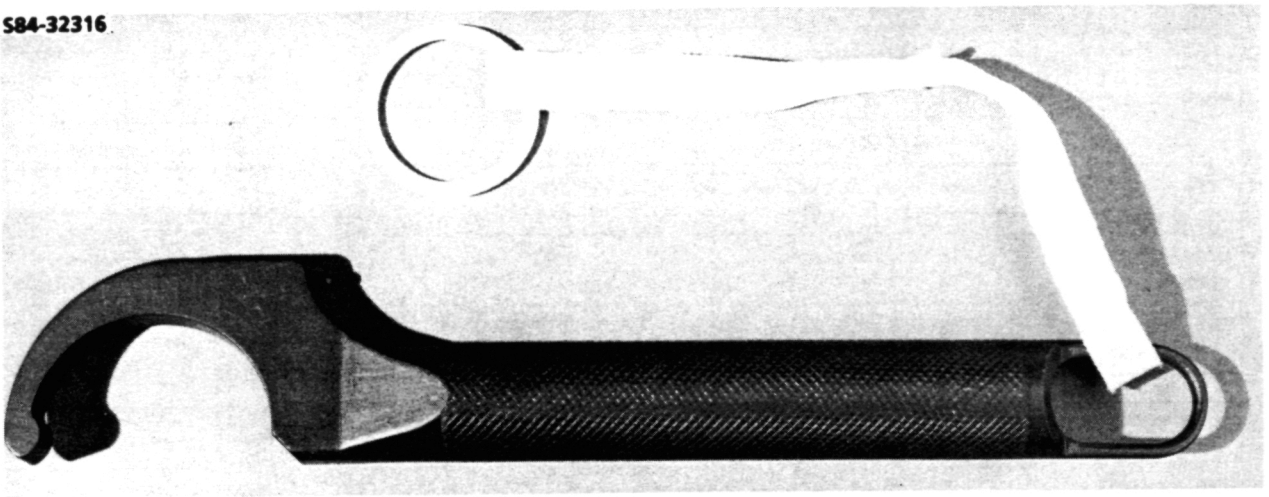
Dimensional Data	
A	8.3 in.
B	3.0 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

HYDRAZINE SPANNER WRENCH

S84-32316



OVERVIEW

The hydrazine spanner wrench is part of the hydrazine servicing tool (HST) set. It is a special-purpose tool which is used with the HST set and the orbital refueling system (ORS) to refuel on-orbit satellites from the STS. The HST set connects to the fill and drain valve of the orbiting satellite. This tool has a large hook-shaped opening at one end, a headless pin behind the large opening, and a tether ring attached to the other end.

OPERATIONAL COMMENTS

The hydrazine spanner wrench large opening is used to tighten and/or loosen the silver knob of the seal verification tool. The small opening with the pin is used to tighten or loosen the multipurpose tool fitting connection.

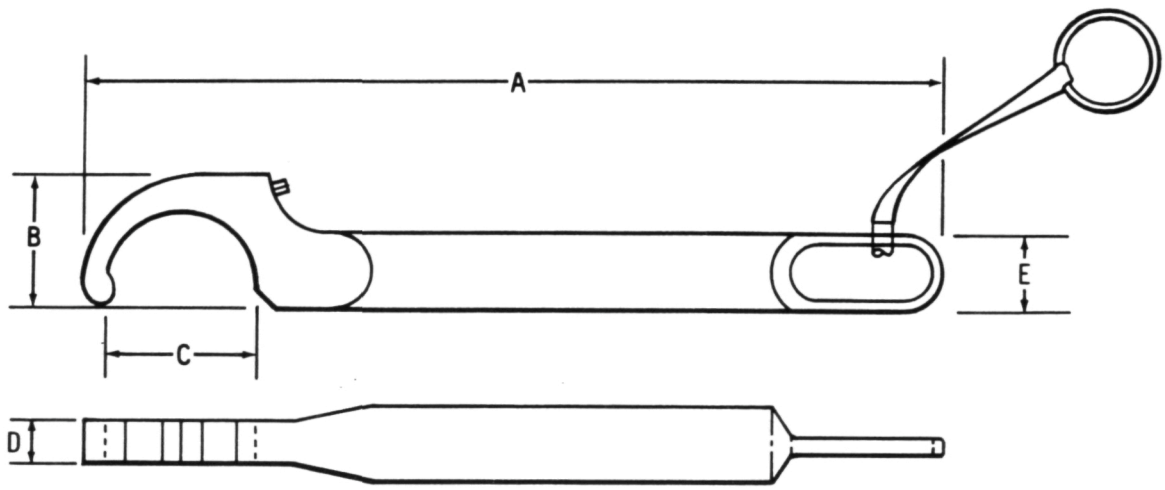
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: T. M. Grubbs, NASA/EC5, (713) 483-9149
Source: T. M. Grubbs, NASA/EC5, (713) 483-9149

HYDRAZINE SPANNER WRENCH

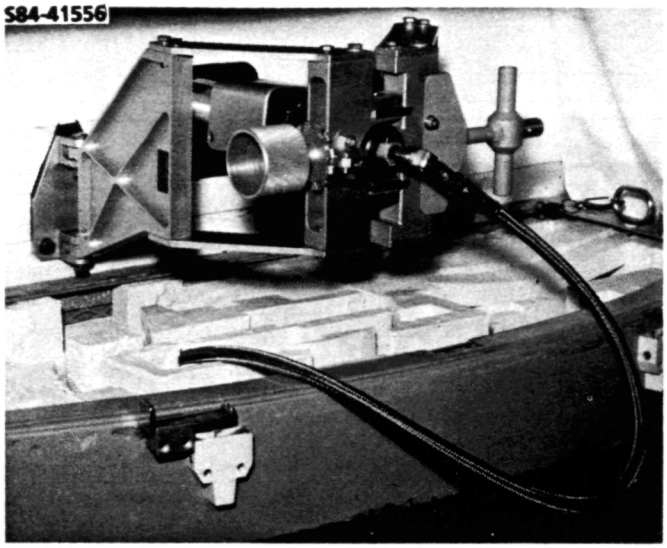
Technical Information	
Part number	SED 39116524-301
Weight	0.54 lb
Material	Anodized aluminum
Force/torque	Rotate multipurpose tool - 105 ± 50 in-lb maximum
Cutting edge opening	5/16 in. high 3/16 in. opening
Design temperature range	35° to 150° F
Availability	Flight specific

Dimensional Data	
A	10.25 in.
B	1.75 in.
C	2.01 in.
D	0.50 in.
E	1.00 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

HYDRAZINE TOOL SUPPORT BRACE



OVERVIEW

The hydrazine tool support brace is part of the orbital refueling system (ORS) which is used to refuel on-orbit satellites from the STS. The tool support consists of two braces which swing together to support the multi-purpose tool.

OPERATIONAL COMMENTS

The hydrazine tool support braces are rotated 120° toward each other to capture the multipurpose tool and are locked together by engaging the lock pin. The multipurpose tool is secured by tightening and locking the jam screw. Pressing a release button on the T-handle unlocks the braces. This tool is permanently attached to the ORS and, therefore, is flown only with the ORS.

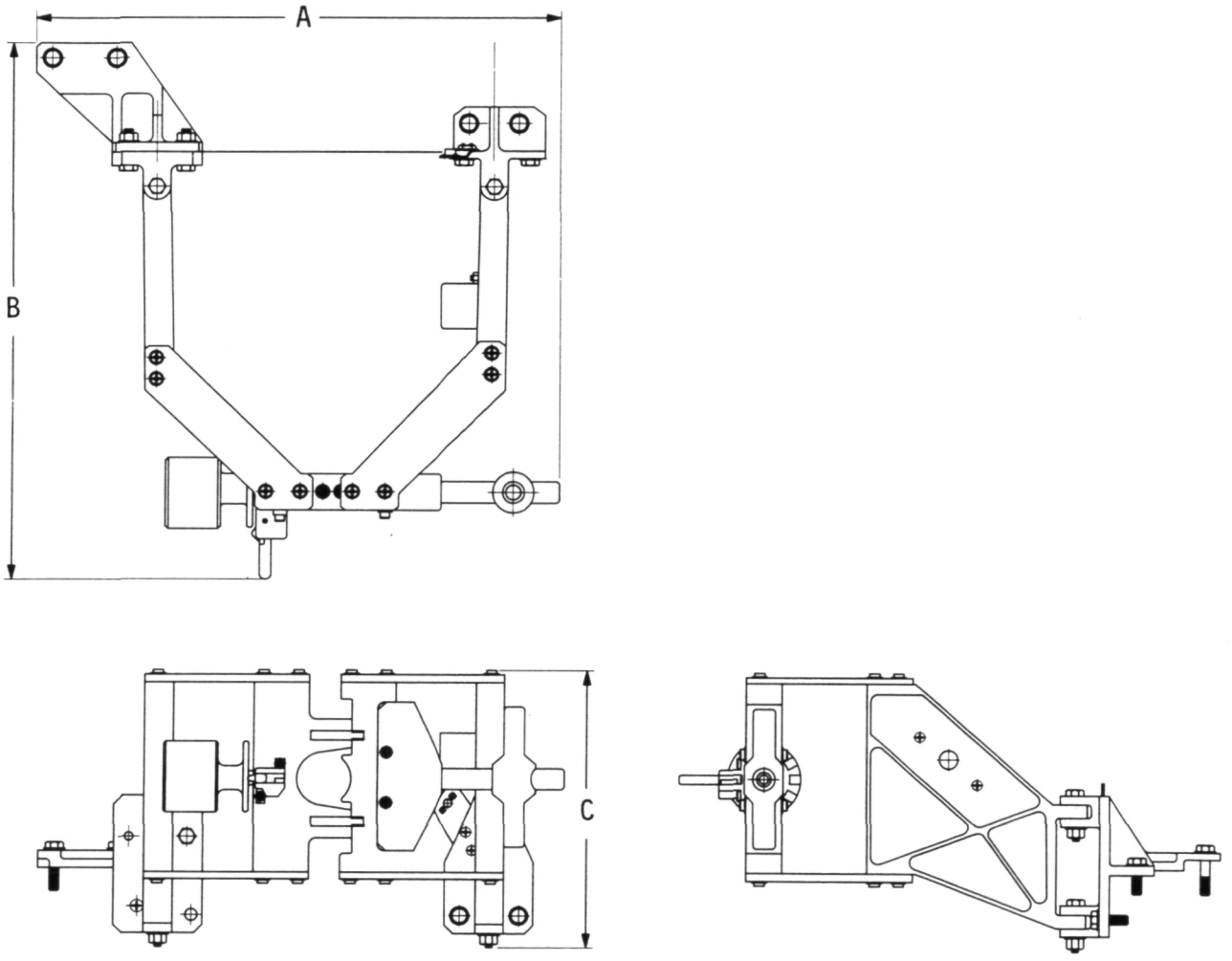
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: T. M. Grubbs, NASA/EC5, (713) 483-9149
Source: T. M. Grubbs, NASA/EC5, (713) 483-9149

HYDRAZINE TOOL SUPPORT BRACE

Technical Information	
Part number	SED 39116380
Weight	4.0 lb (each brace weighs 2.0 lb)
Material	Anodized aluminum
Force/torque	Installed brace - 150 ± 50 in-lb max
Design temperature range	35° to 150° F
Availability	Flight specific

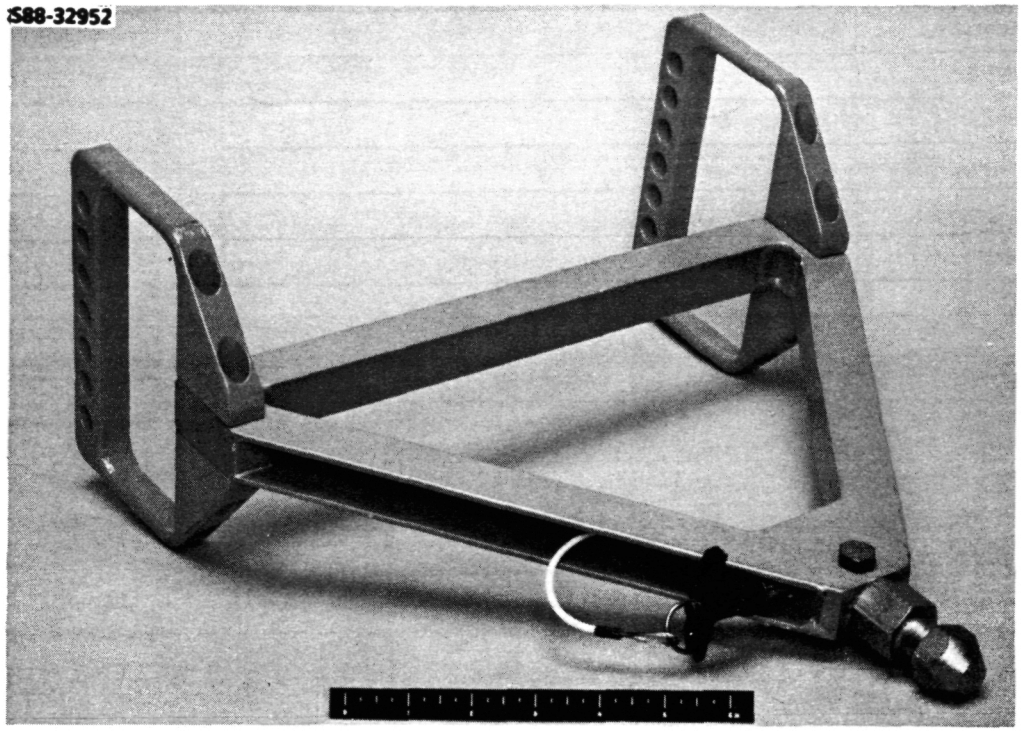
Dimensional Data	
A	14.625 in.
B	15.125 in.
C	7.938 in.



204660079.ART, 3

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

JETTISON HANDLE



OVERVIEW

The jettison handle is a contingency tool designed for the Hubble Space Telescope. (HST) If the HST must be returned to the payload bay, all appendages must be folded back into their original positions. If, for some reason, an appendage is unable to be returned to its original position, either automatically or manually, the EVA crewmember must then jettison the appendage using the jettison handle. The solar arrays and aperture door have a mounted socket which mates with the jettison handle.

OPERATIONAL COMMENTS

The jettison handle connects into a socket located on the failed appendage near the center of gravity of the appendage and provides a means of holding the appendage structure for easy movement away from the HST. The socket fitting is similar to a portable foot restraint socket.

CONTACTS

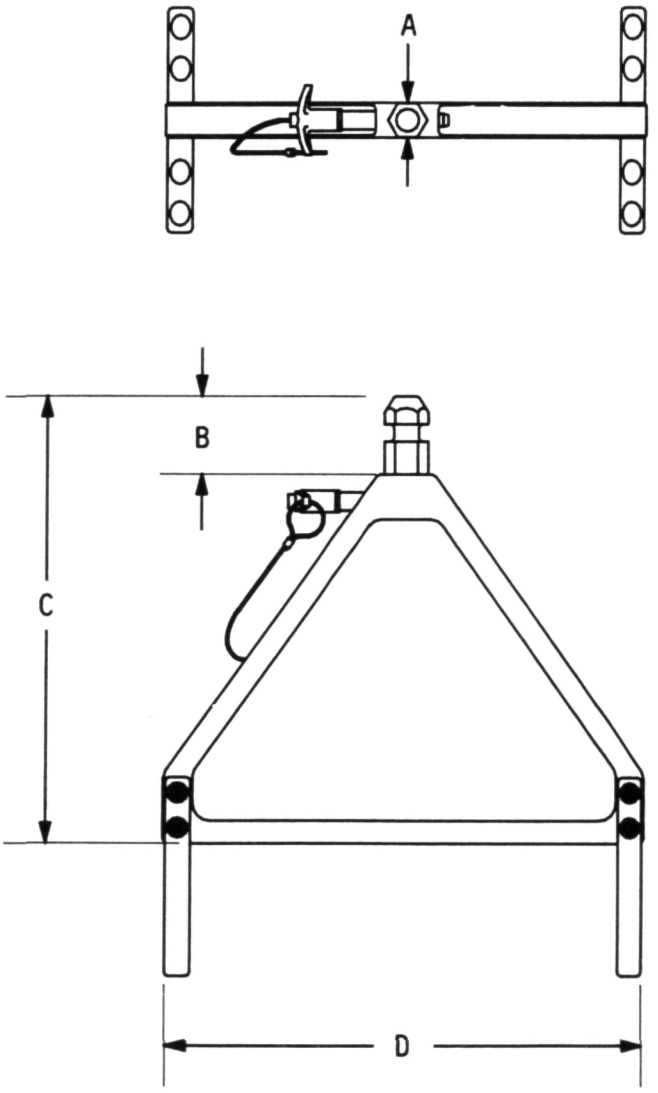
Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. Sheffield, LMSC/Dept. 64-10, (408) 742-8464
Source: LMSC, HST Contracts Office, (408) 742-5505

Section I
PAGE INTENTIONALLY BLANK
PRECEDING PAGE BLANK NOT FILMED

JETTISON HANDLE

Technical Information	
Part number	1175850
Weight	2.95 lb
Material	Aluminum alloy
Availability	Flight specific

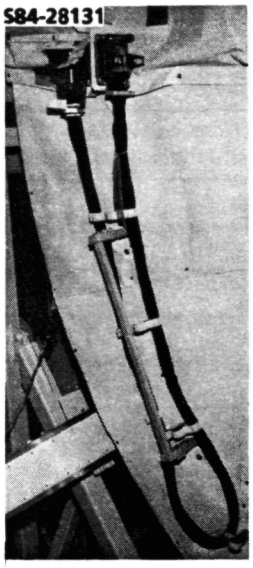
Dimensional Data	
A	0.980 in.
B	2.250 in.
C	12.720 in.
D	13.540 in.
E	5.650 in.
F	6.500 in.



204660080.ORT, 2

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

JUMPER CABLE



OVERVIEW

The jumper cable is an 11-foot electrical cable with a female electrical connector on one end and a male electrical connector on the other. Each end has two captive bolts used in mating the jumper cable to the desired interface. A tether ring is provided on both sides of the male connector.

OPERATIONAL COMMENTS

The jumper cable was designed to provide an electrical interface during the servicing of the Solar Maximum Satellite (Solar Max). The jumper cable is manually mated to the Solar Max connector. The two bolts on the jumper cable connector are tightened by rotating approximately seven full turns clockwise with a tool having a 7/16-inch hex socket. This procedure is then repeated with the other end of the jumper cable at the flight support system (FSS) umbilical connector actuator position.

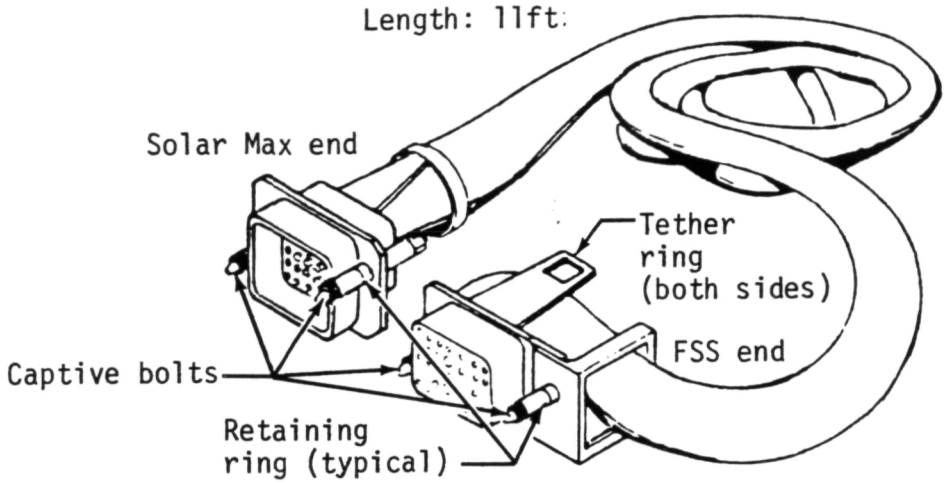
CONTACTS

Operational: R. McDaniel, NASA/DF42, (713) 483-2570
Technical: K. Olson, NASA/GSFC, (301) 286-3230
Source: K. Olson, NASA/GSFC, (301) 286-3230

JUMPER CABLE

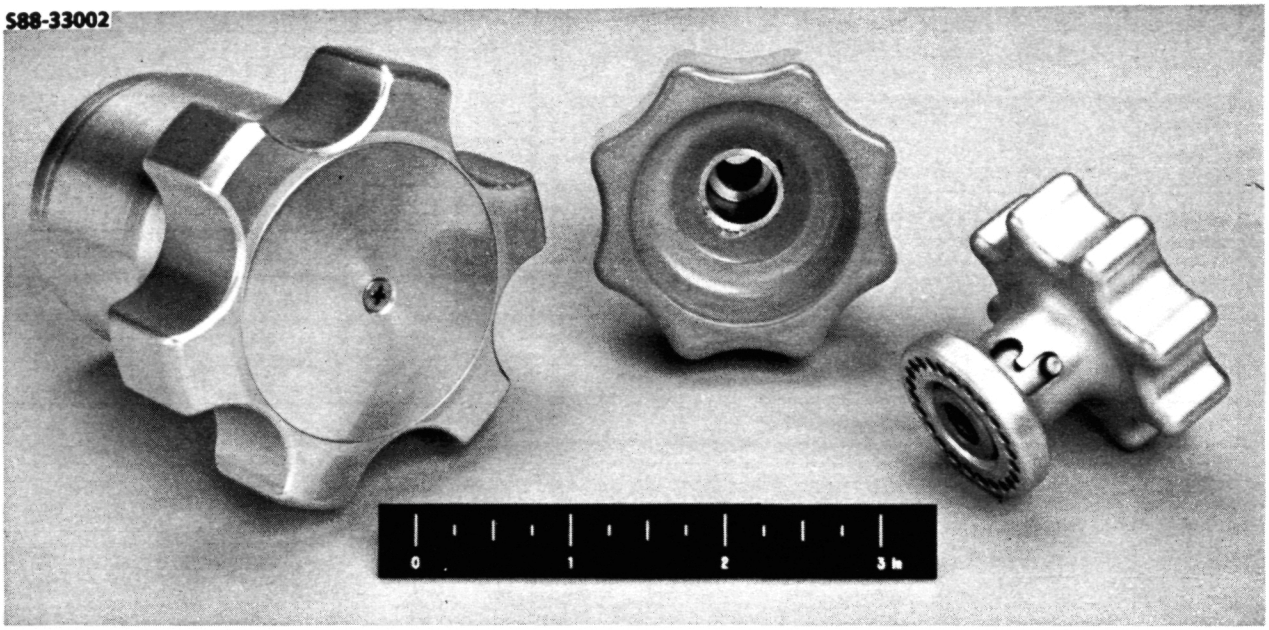
Technical Information	
Part number	9390000608
Weight	17 lb
Material	Cable - black Teflon webbing Connector housing - irradiated aluminum
Temperature range	-94° to +158° F
Availability	Flight specific

Dimensional Data	



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

KNOB, EVA



OVERVIEW

EVA knobs come in a variety of styles. The requirements of the item which incorporates a knob determine the knob style used. Each knob produced for EVA use is designed for ease of use by the gloved hand. With that in mind, EVA knobs are scalloped to facilitate the grasp of the gloved hand and to minimize slipping when the knob is turned.

OPERATIONAL COMMENTS

The photograph shows three types of knobs. The knob on the left is used to adjust the position of the mini work station (10150-10054-01) which mounts on the front of the extravehicular mobility unit (EMU). The middle knob is part of the manned maneuvering unit (MMU) donning station. The knob style shown on the right is used on the portable foot restraint (PFR) and a variety of PFR-related items, including the articulating socket, centerline clamp, telescoping boom, work station stanchion, sill longeron, and bridge attachment clamp. This particular style incorporates a locking feature.

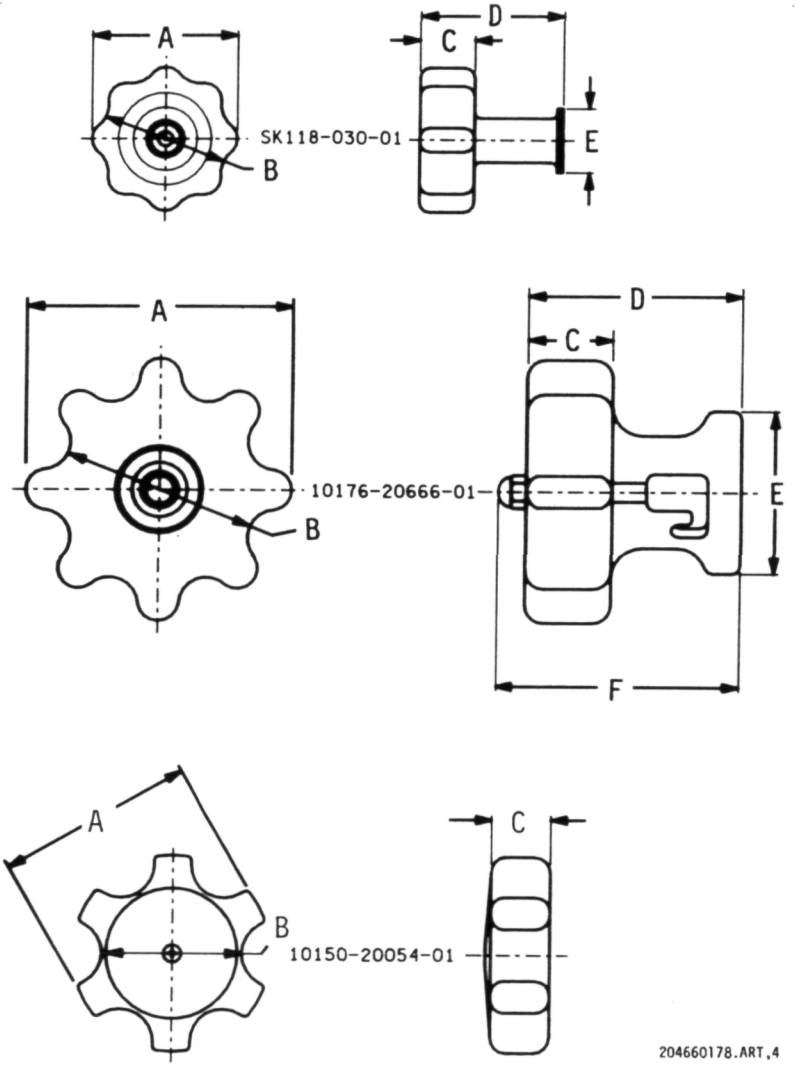
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

KNOB, EVA

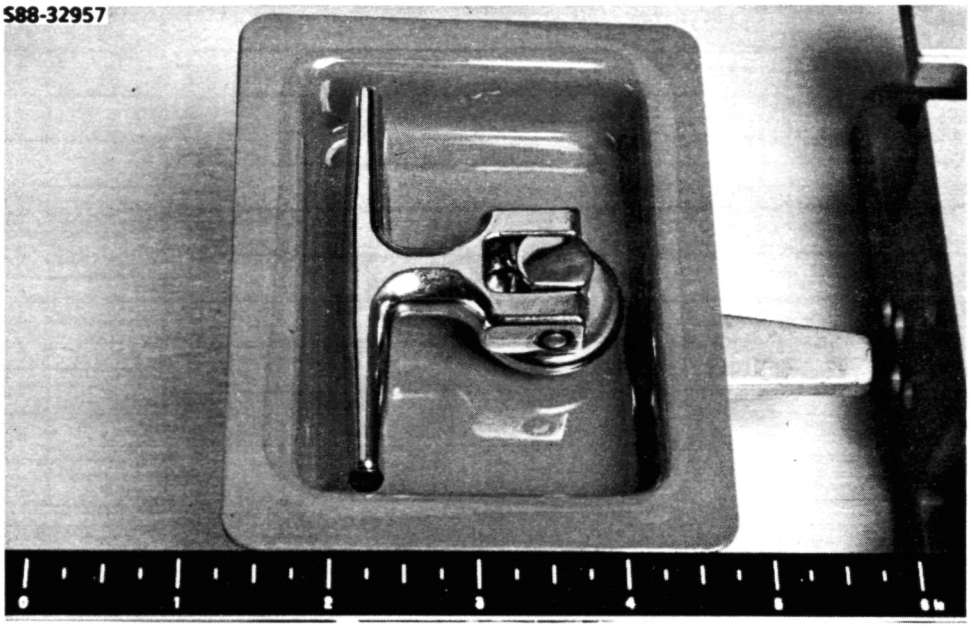
Technical Information	
Part number	SK118-030-01 (MMU FSS) 10150-20054-01 (MWS) 10176-20666-01 (PFR)
Weight	SK118-030-01 0.198 lb 10150-20054-01 0.174 lb 10176-20666-01 0.150 lb
Material/ construction	Aluminum
Temperature range	-150° to +250° F (operational)
Availability	Flight specific

Dimensional Data			
	SK118-	10176-	10150-
A	2.25 in.	2.00 in.	3.00 in.
B	2.00 in.	1.50 in.	2.12 in.
C	0.80 in.	0.62 in.	1.02 in.
D	2.25 in.	1.60 in.	-
E	1.00 in.	1.25 in.	-
F	-	2.69 in.	-



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

LATCH, 1/4-TURN DOOR



OVERVIEW

The 1/4-turn door latch was developed for use on the flight support system (FSS) locker (10172-20001-01) which was flown on STS 41-C. This door latching system incorporates a yellow housing for easy identification in the cargo bay and a large turning handle for gloved-hand use. The handle has a large tether ring which makes it easy to grasp, and it folds into the housing for stowage. This door latch style can be incorporated into a variety of stowage containers.

OPERATIONAL COMMENTS

The crewmember lifts the tether ring to take the handle from the housing and rotates it 90 degrees to unlatch the locker door. There are two latches on each door of the FSS locker, requiring that the procedure be repeated four times to open both doors of the locker.

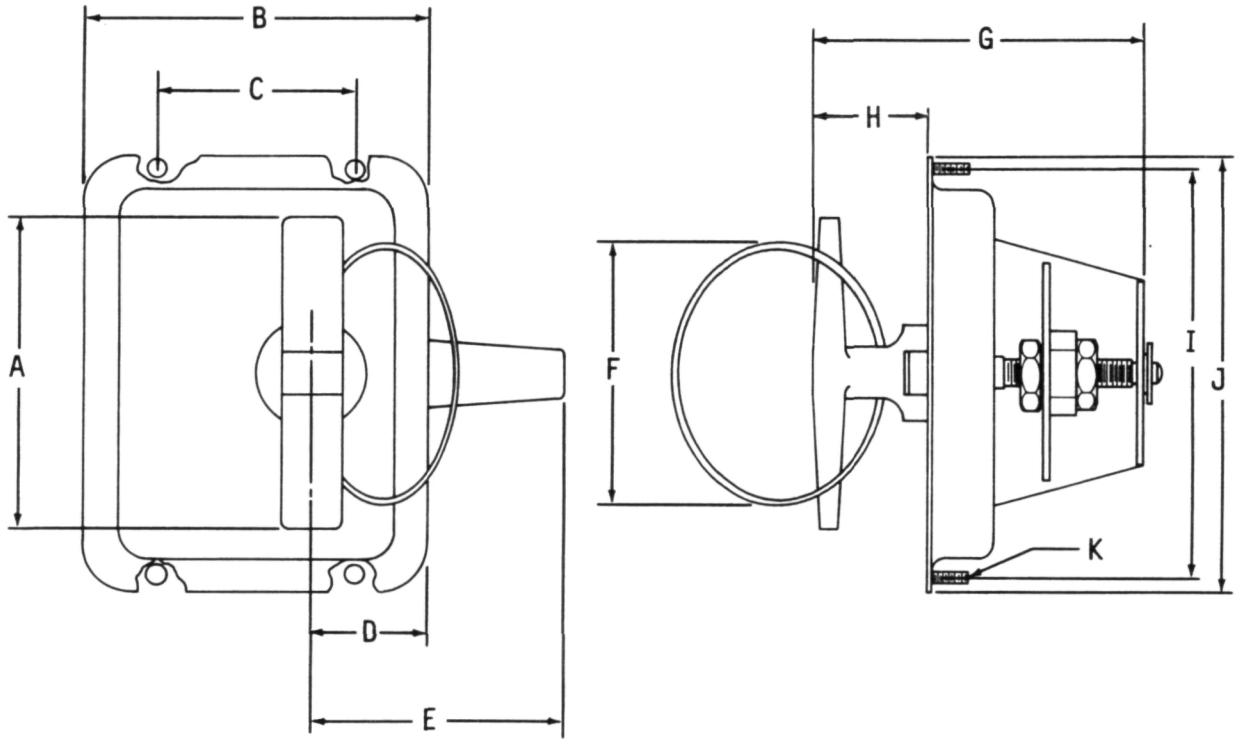
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

LATCH, 1/4-TURN DOOR

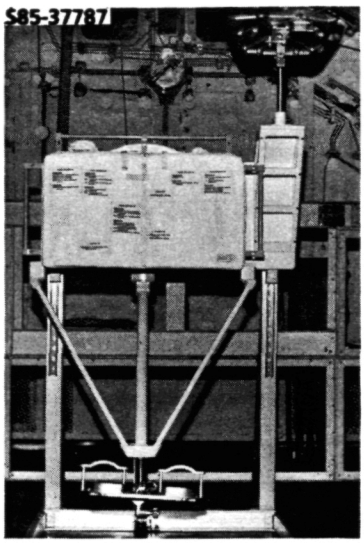
Technical Information	
Part number	10172-20016-01
Weight	1.05 lb
Material/ construction	Aluminum Stainless steel
Temperature range	-130° to +150° F (operational)
Color	Yellow
Availability	Flight specific

Dimensional Data	
A	3.25 in.
B	3.50 in.
C	2.00 in.
D	1.19 in.
E	2.56 in.
F	2.75 in.
G	3.75 in.
H	1.19 in.
I	4.19 in.
J	4.50 in.
K	.190-24 UNC



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

LEASAT EQUIPMENT STOWAGE ASSEMBLY



OVERVIEW

The Leasat equipment stowage assembly (LESA) consists of a tool container assembly (TCA) with tools and equipment stowed inside on tool boards and tool caddies, a TCA foot restraint structure (not shown in drawing front view), a work station foot restraint, a work station support structure, and a mounting plate to which the TCA and work station support structure are attached. The mounting plate is match-drilled for attachment to a get-away special (GAS) beam on the starboard side of the cargo bay (to avoid interference with the operation of the remote manipulator system).

OPERATIONAL COMMENTS

The LESA stows tools and parts used in satellite salvage and repair operations and supports crewmembers while removing and replacing tools in the TCA and while working on the satellite. It was designed specifically for the LEASAT Salvage Mission, STS 51-I. For that mission, the TCA contained five tool boards and three caddies, although the LESA interior could be modified to accommodate different tool requirements for future EVA missions.

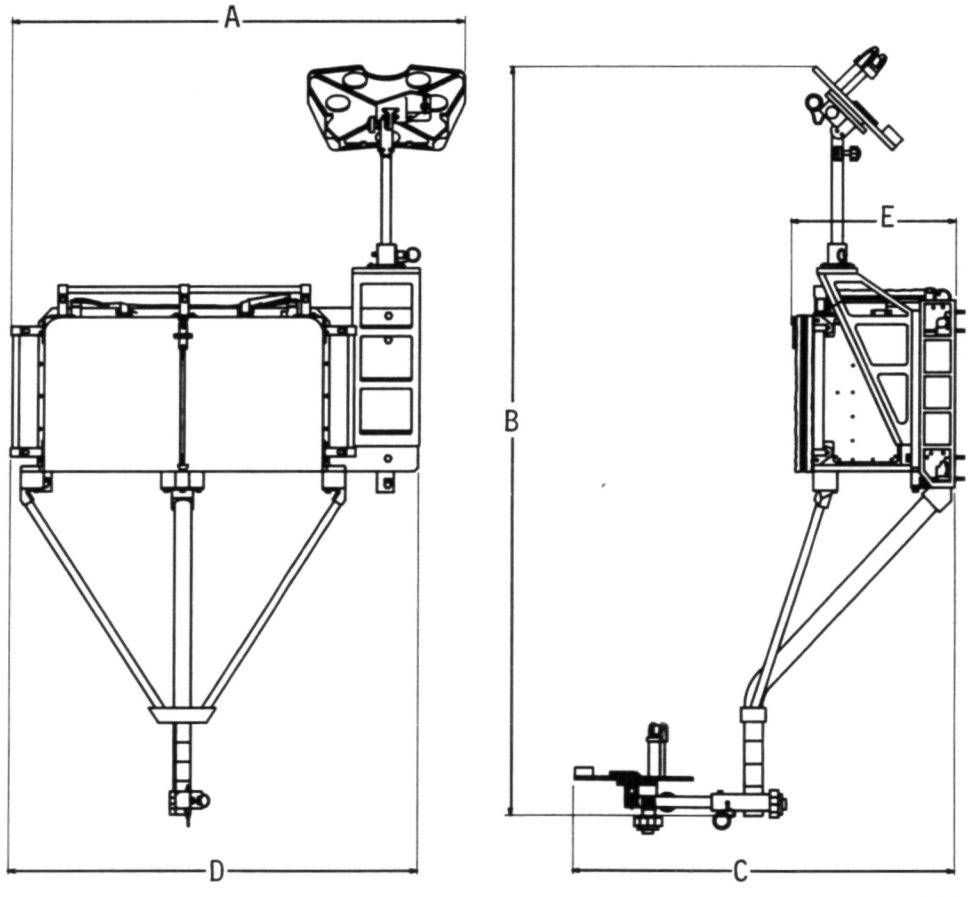
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

LEASAT EQUIPMENT STOWAGE ASSEMBLY

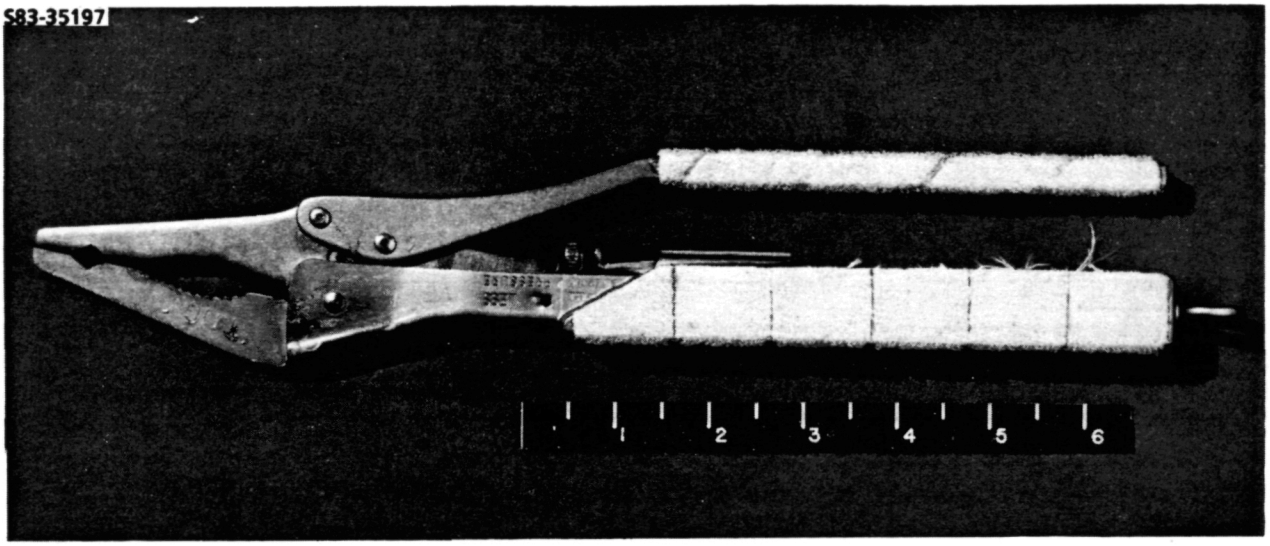
Technical Information	
Part number	10176-20005-01
Weight	188.0 lb 259.2 lb (full with 2 PFRs) 441.2 lb (full with 2 PFRs and GAS beam)
Components:	
TCA	10176-20003-01
TCA foot restraint structure	10176-20060-01 and 10173-20168-01
Mounting plate	10176-20005-01
Work station support structure	10176-20601-01
Portable foot restraint	10176-20060-01
Internal stowage volume of TCA	2.14 ft^3
Stowage	Cargo bay
Availability	Flight specific

Dimensional Data	
A	53.60 in.
B	92.00 in.
C	45.75 in.
D	49.75 in.
E	18.25 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

LEVER WRENCH



OVERVIEW

The lever wrench is a self-adjusting vise-grip plier with a clamping-jaws design which includes a size and force adjustment screw on the handle. Force placed on the nut by the wrench can be set with the adjusting screw. An astro ring is fixed to one of the handles for tether attachment. Both handles are wrapped with Velcro.

OPERATIONAL COMMENTS

The lever wrench is a disconnect and jam removal tool used to grasp the nut during nut and bolt removals. In order to use the self-adjusting feature, the handles must first be fully opened, the fixed jaw placed against the nut, and the handles then closed. The wrench has a maximum opening of 1-5/16 inches. Normally, the force adjustment screw will be pre-set before stowage so that no adjustment will be required.

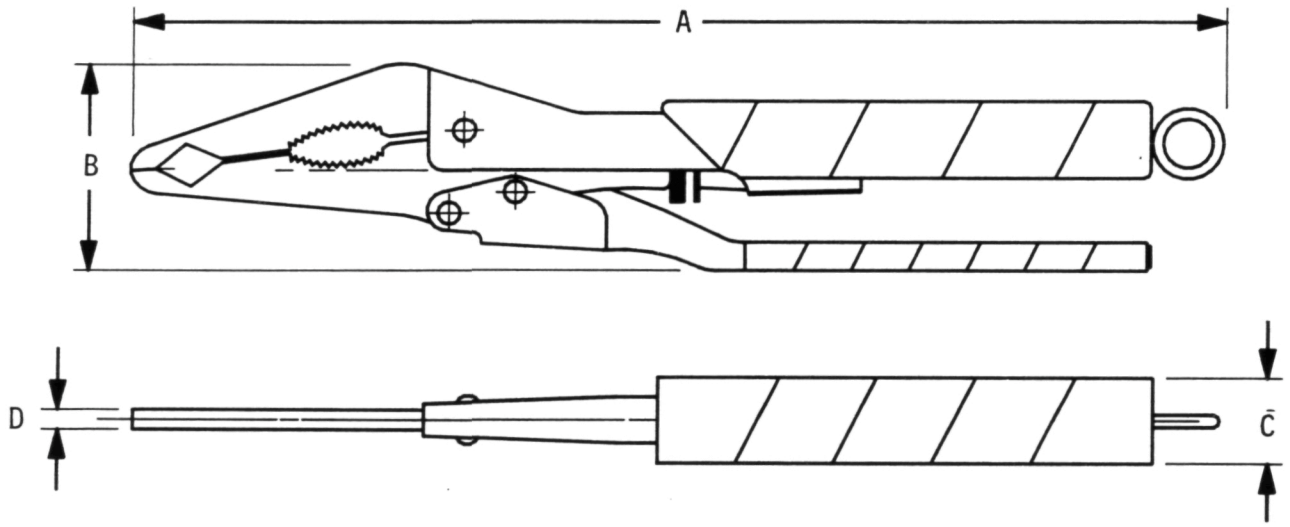
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: J. Madden, Rockwell/Houston, (713) 282-5300

LEVER WRENCH

Technical Information	
Part number	V628-650878-003
Weight	1.5 lb
Material	Tool steel
Construction	Handles - wrapped with Velcro, tether ring on large handle Jaws - notched, serrated
Opening	Adjustable with screw
Maximum opening	1-5/16 in.
Availability	Reference only

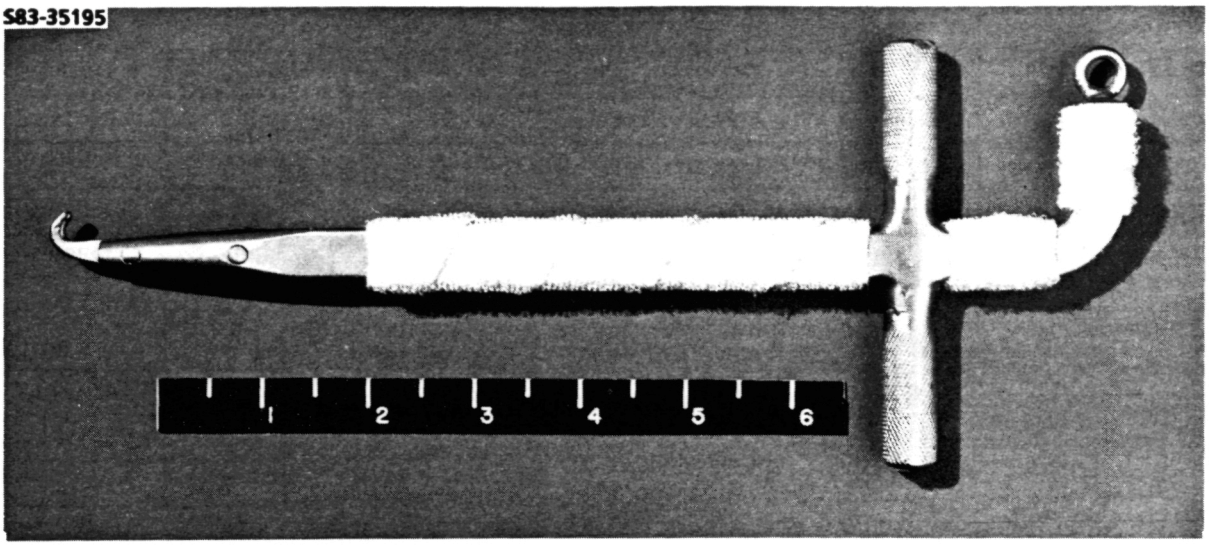
Dimensional Data	
A	12.900 in.
B	2.400 in.
C	0.800 in.
D	0.188 in



204660082.ORT, 5

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

LOOP PIN EXTRACTOR



OVERVIEW

The loop pin extractor was designed to pull or pry loose the loop pins or cotter pins used on the Space Shuttle. The tool has a hook on one end which is inserted into the eye of the loop pin for removal; near the opposite end is a T-bar which provides grip for the EVA crewmember during pin removal. The handle is wrapped in Velcro and has a ring for tether attachment.

OPERATIONAL COMMENTS

This tool is basic to all nut and bolt disconnects of the bulkhead latches and door drive. The tool is inserted into the eye of the loop pin, and the pin is removed by pulling or prying. The tool may also be used for jam removal. The loop pin extractor is part of the normally manifested STS equipment. It is wrapped in a Velcro-lined tool caddy along with the power drive unit (PDU) disconnect and stowed in the starboard provisions stowage assembly (PSA).

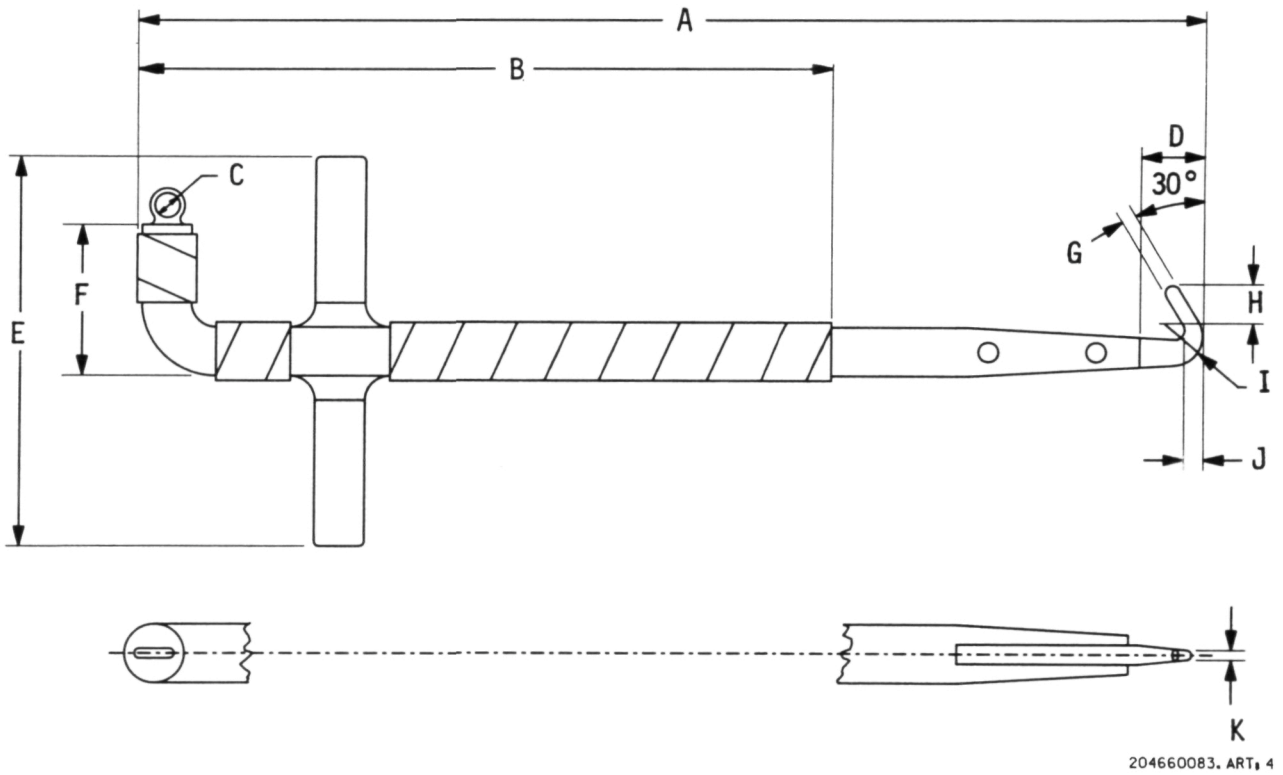
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: J. Madden, Rockwell/Houston, (713) 282-5300

LOOP PIN EXTRACTOR

Technical Information	
Part number	V628-650998-001 or SDD33103433-301
Weight	0.8 lb
Material	Tool steel with aluminum handle
Temperature range	-200° to 250° F (operational)
Quantity flown	One in starboard PSA
Availability	Standard

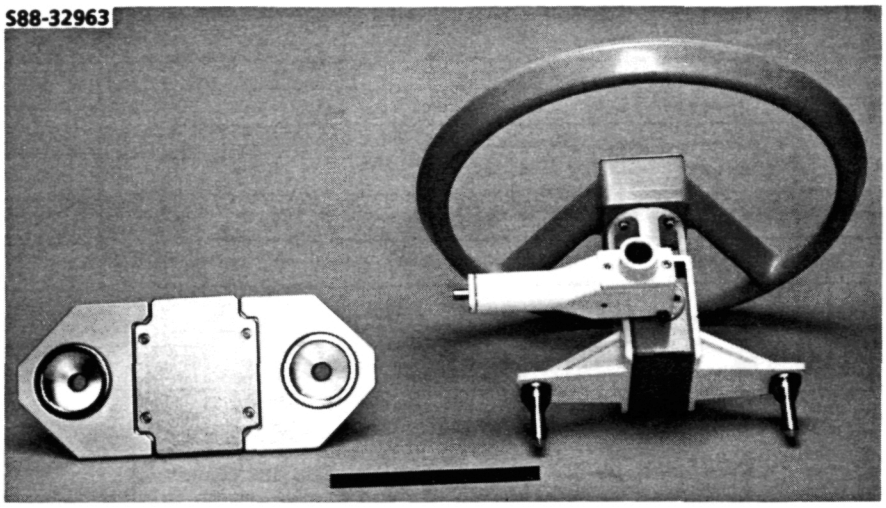
Dimensional Data	
A	10.00 in.
B	7.00 in.
C	0.25 in.
D	0.43 in.
E	4.00 in.
F	1.60 in.
G	0.10 in.
H	0.22 in.
I	0.25 in.
J	0.10 in.
K	0.10 in.



204660083. ART. 4

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

MAGNETIC HANDLING AID



OVERVIEW

The magnetic handling aid (MHA) is one of a family of magnetic tools developed and designed by NASA engineers. The MHA is to be used during the proposed Shuttle Radiator Assembly Demonstration (SRAD) flight experiment. This mission will demonstrate a crewmember's ability to assemble the 50-foot long heat pipe radiators and administer subsequent maintenance activities associated with three possible methods of radiator handling. The method which will be utilized involves an EVA crewmember with an MHA in the manipulator foot restraint (MFR) attached to the remote manipulator system (RMS). The MHA is the EVA hand-held version of the RMS magnetic end effector.

OPERATIONAL COMMENTS

The MHA provides the EVA crewmember with a method of manually handling a radiator element. Attachment of the MHA is accomplished by an interface between an insert installed in the radiator and an Eriez rare earth magnet. The MHA has a grip wheel configuration for multidirectional handling while attached to the radiator. It also provides an EVA handle giving one-handed operation to polarize and depolarize the magnet. The handle uses 180° lock-on and lock-off positions. A standoff or pedestal is attached between the wheel and the magnet saddle to allow for proper grip and clearance above the radiator stacked configuration.

The MHA is currently in prototype form with critical design review (CDR) pending. A high-fidelity mockup of this unit also exists.

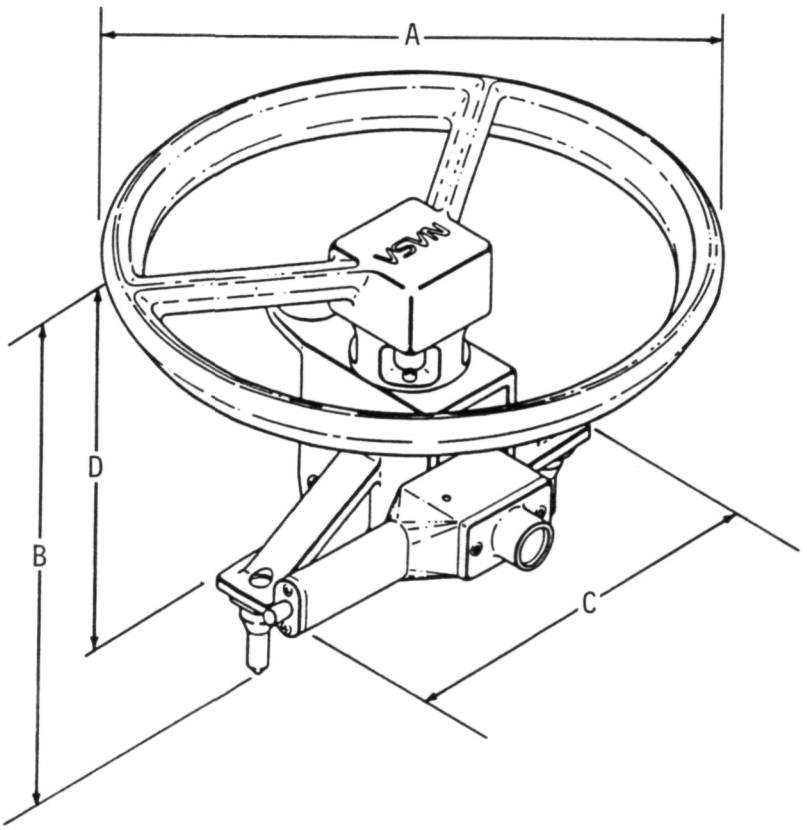
CONTACTS

Operational: R. C. Trevino, NASA/DF4, (713) 483-2597
Technical: C. E. Whitsett, NASA/EC5, (713) 483-9111
Source: L. Willis, NASA/EC5, (713) 483-9153

MAGNETIC HANDLING AID

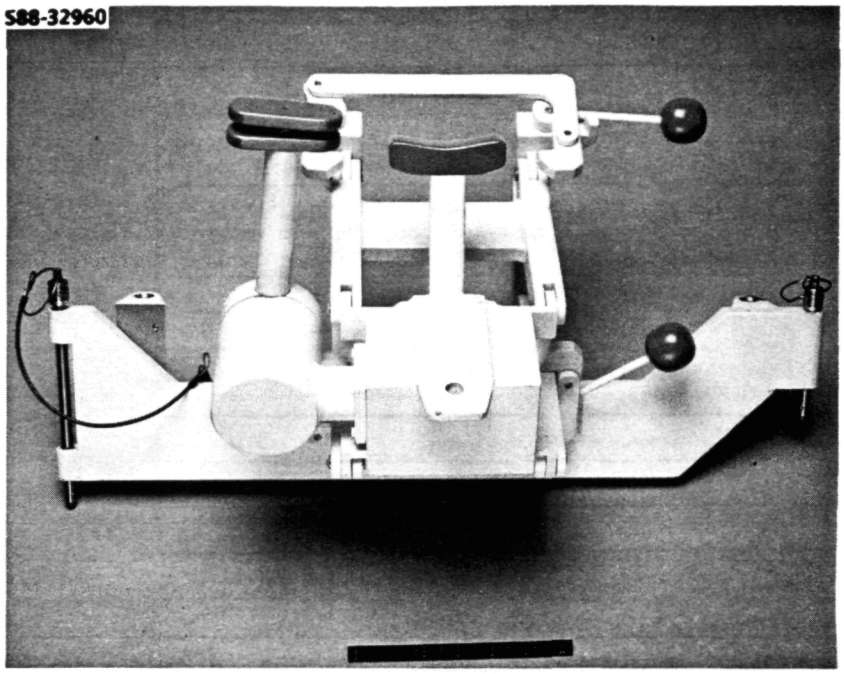
Technical Information	
Part number	Not available
Weight	15.0 lb (est) 20 lb (max.)
Material	Aluminum alloy, 6061-T6 rare earth magnet
Temperature range	±200° F
Availability	Developmental

Dimensional Data	
A	15.44 in.
B	10.25 in.
C	9.00 in.
D	8.25 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

MAGNETIC PANEL ATTACHMENT DEVICE



OVERVIEW

The magnetic panel attachment device (MPAD) is a mechanical interface between the manned maneuvering unit (MMU) and a radiator panel typical to Space Station Freedom. Two quick disconnect pip pins attach the MPAD to the arms of the MMU and a magnet on the MPAD attaches to a ferrous steel insert located on the radiator panel. The MPAD may be used during the proposed Shuttle Radiator Assembly Demonstration (SRAD) flight experiment.

OPERATIONAL COMMENTS

The MPAD must first be attached to the MMU before the MMU can position the MPAD for capture of a panel. The MMU is used to insert the docking tab at the tip of the MPAD into the docking insert on the panel. A small (soft dock) magnetic force is applied at insertion. Once soft dock is achieved, a large (hard dock) magnetic force is applied prior to flying with the panel.

The MPAD provides two geometric positions: docking/flying position and retracted position within grasping reach of the MMU operator's gloved hands.

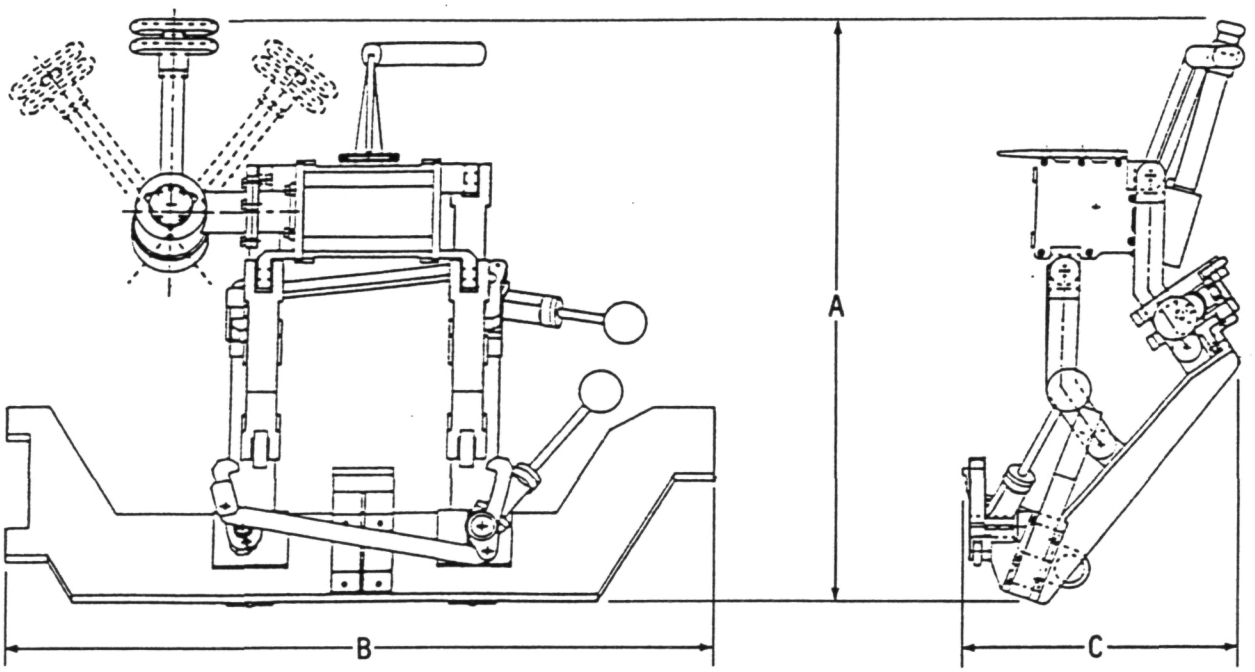
CONTACTS

Operational: R. C. Trevino, NASA/DF4, (713) 483-2597
Technical: S. W. Dunavent, ILC/EC5, (713) 483-9154
Source: M. Withey, ILC Space Systems, (713) 488-9080

MAGNETIC PANEL ATTACHMENT DEVICE

Technical Information	
Part number	SED 3911 8650
Weight	30 to 40 lb (TBD)
Material	Stainless steel, aluminum alloy, ferrous magnetic carbon steel, aluminum, bronze
Major components	Magnet, magnetic force control box, geometric position change locks, articulating and support structure
Design temperature range	-150° to 200° F
Stowage	Bolt on stowage assembly SED 3911 8660
Availability	Developmental

Dimensional Data	
A	21.0 in.
B	24.0 in.
C	10.0 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

MANIPULATOR FOOT RESTRAINT

S84-27021

OVERVIEW

The manipulator foot restraint (MFR) is a crewmember restraint device and work station which is grappled by the remote manipulator system (RMS). It consists of a lower base with a standard RMS grapple fixture and a latch and roller assembly for attaching the MFR to the adaptive payload carrier (APC). On top of the lower base is the MFR base, supporting the foot restraint platform and vertical stanchion. The upper portion of the stanchion, the work station, includes handholds, space for two removable tool boards, and the payload interface mechanism (PIM). A safety tether is attached to the foot restraint platform for crewmember use. Several parts of the MFR rotate to provide a wide range of crewmember motion. A short tether is provided for attaching the MFR to the RMS end effector handrail.

OPERATIONAL COMMENTS

The MFR provides for EVA crewmember translation, positioning, and restraint in cargo bay worksites within reach of the RMS. Positioning of the MFR is by voice link with the RMS operator in the cabin.

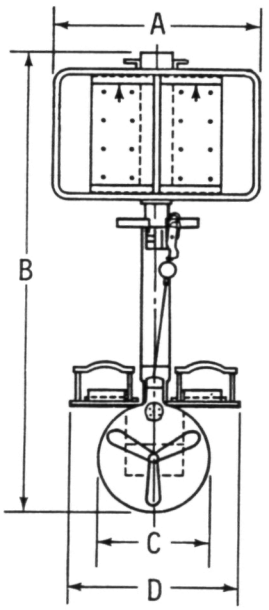
CONTACTS

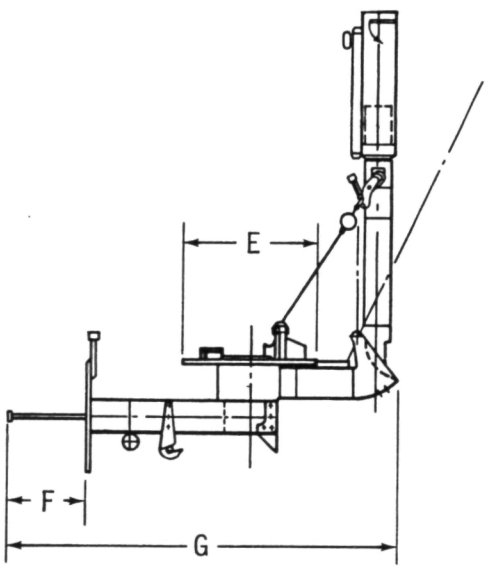
Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: T. Ross, NASA/ES6, (713) 483-8941
Source: T. Ross, NASA/ES6, (713) 483-8941

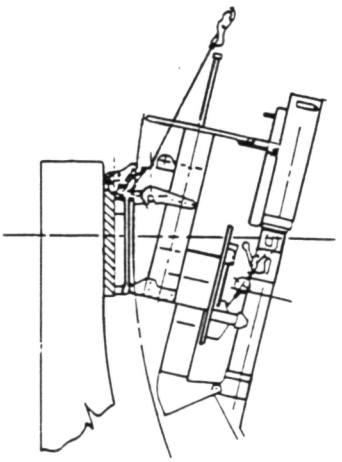
MANIPULATOR FOOT RESTRAINT

Technical Information	
Part number	SED33103150-305 (MFR), 10159-10028-01 (MFR/RMS tether)
Weight	58 lb, 83 lb with APC
Material	Primarily aluminum
Rotation of MFR base including vertical stanchion	±180° with locking in 45° increments
Tilt of stanchion away from crewmember	27° forward with locking in 9° increments
Rotation of work station about vertical stanchion axis	±180° with locking in 45° increments
Rotation of foot platform independent of base	Continuous 360° with locking in 30° increments
Stowage	Cargo bay, attached to APC
Availability	Flight specific

Dimensional Data	
A	25.0 in.
B	61.5 in.
C	14.0 in.
D	20.5 in.
E	14.5 in.
F	8.0 in.
G	52.5 in.







STOWED POSITION

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

MANNED MANEUVERING UNIT

OVERVIEW

The manned maneuvering unit (MMU) is a modular, self-supporting backpack, containing its own electrical power, propulsion system, and controls. It readily attaches to the extravehicular mobility unit (EMU) and can be donned, doffed, and serviced by one EVA crewmember for use as required during a nominal 6-hour EVA. It has complete six-degree-of-freedom control authority and automatic attitude hold capability. It provides attachment points for the use of ancillary equipment such as satellite docking mechanisms, tools, portable lights, cameras, and instrument sensors. The propellant is gaseous nitrogen, which is noncontaminating.

OPERATIONAL COMMENTS

The MMU is used to increase the EVA crewmember's mobility by extending the range of activities from the cargo bay to other portions of the spacecraft, to appendages of payloads protruding from the cargo bay, or to other spacecraft. It can be used to carry cargo of moderate size, to stabilize satellites, to retrieve small free-flying payloads, and to provide remote photography/television of Shuttle operations.

Two MMU's are normally manifested. On past missions, the MMU has been used with the apogee kick motor capture device (ACD), the trunnion pin attachment device (TPAD), and 35-mm camera provisions. The MMU is stowed in the forward cargo bay (1) on the flight support station (FSS) designed specifically for that purpose.

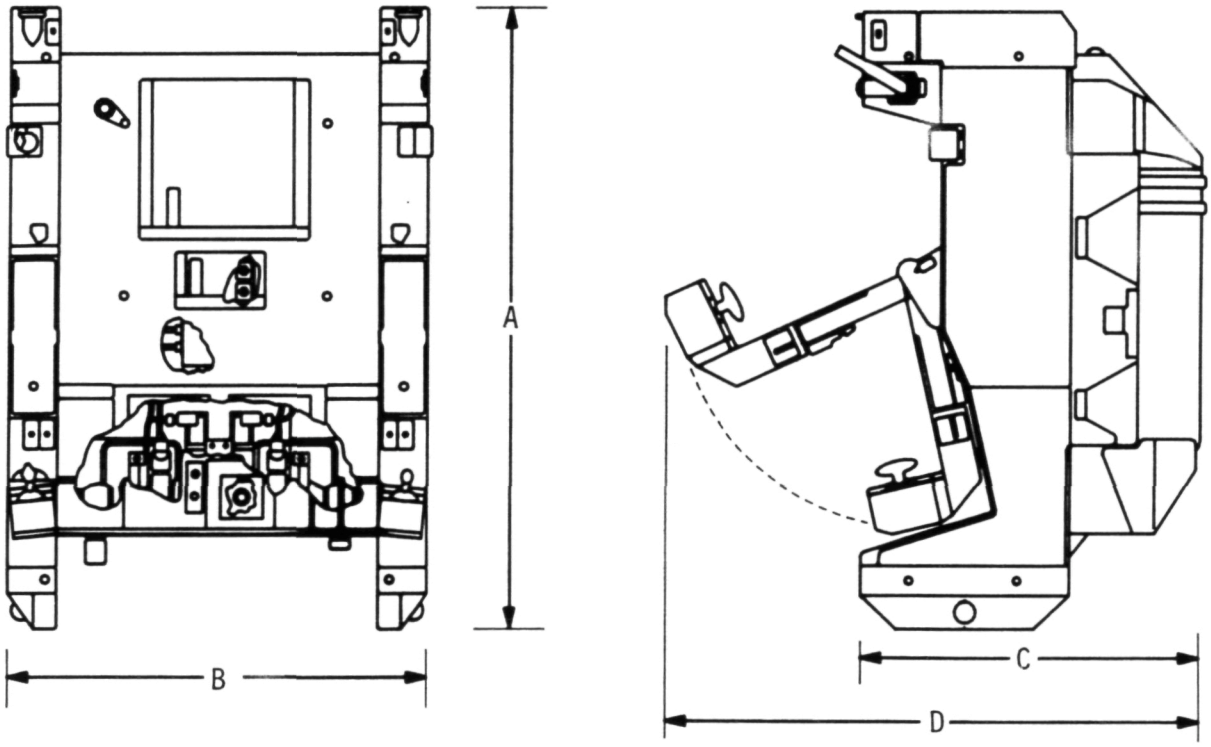
CONTACTS

Operational: R. K. Fullerton, NASA/DF4, (713) 483-2589
Technical: C. E. Whitsett, NASA/EC1, (713) 483-9111
Source: S. Curtis, Martin Marietta, Denver, CO, (303) 977-4846

MANNED MANEUVERING UNIT

Technical Information	
Part number	852MU000000
Weight	338 lb
Material	Aluminum skin
Control	Three modes of operation - normal, axis inhibit and satellite stabilization Automatic attitude hold available in all three modes Left hand controller - 3 DOF translation Right hand controller - 3 DOF rotation Translation acceleration - 0.26 to 0.33 ft/sec^2 Rotational acceleration - 7 to 12 deg/sec^2 Redundant logic
Maximum range	400 ft
Electrical power	Two batteries: total power - 26.6 A-hr (minimum)
Propellant	Gaseous nitrogen (24 lb at 3000 psig) Reservicing in less than 10 min
Stowage	Forward cargo bay (bay 1) in FSS
Availability	Flight specific

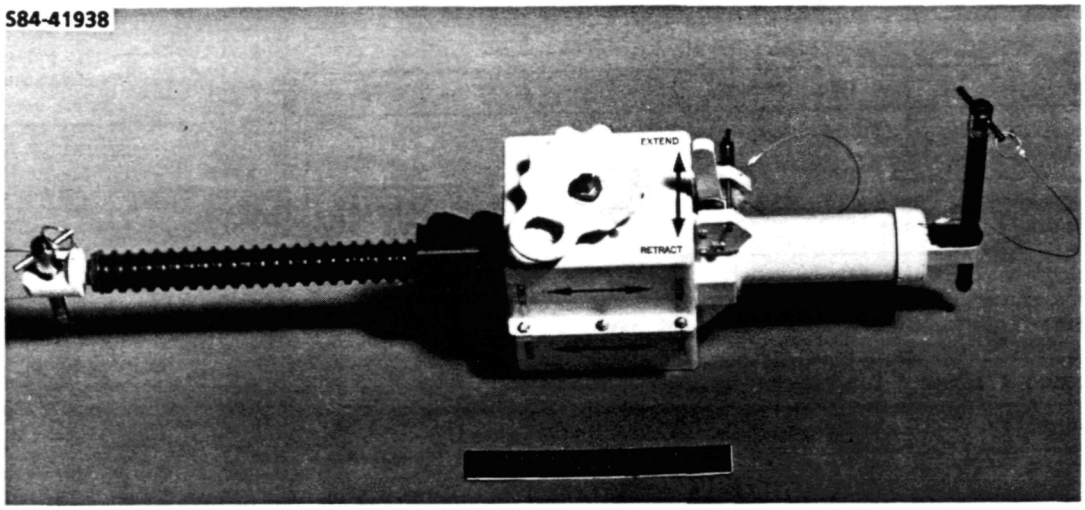
Dimensional Data	
A	50.0 in.
B	33.3 in.
C	27.0 in.
D	48.0 in.



204660183. ORT.2

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

MANUAL AFT FRAME TILT ACTUATOR



OVERVIEW

The manual aft frame tilt actuator (AFTA) is a ball nut jack to raise or lower the tilt table of the inertial upper stage (IUS). This tool would be used for IUS deploy in the event that both the primary and secondary AFTA's fail to respond. It may also be used for tilt table stowage prior to reentry to avoid landing load damage.

OPERATIONAL COMMENTS

Normal installation of the manual AFTA requires that the opposite side AFTA be engaged to restrain the IUS and payload. The IUS/payload may not be unrestrained at any time. Before installing the manual AFTA on the chosen side, the corresponding automatic AFTA must be decoupled by pin puller activation. The manual AFTA is then connected to the tilt table slipring with 3/16-inch-diameter pip pins after verifying slipring engagement. The opposite side automatic AFTA is next released by AFTA pin puller or slipring pin pusher activation. The manual AFTA can then be manually driven to elevate to 45° for deploy or to lower to -6° for stowage. A handwheel provides easy operation. A 7/16-inch wrench must be used to drive the manual AFTA under high loads. A lock lever ensures restraint when the manual AFTA is unattended.

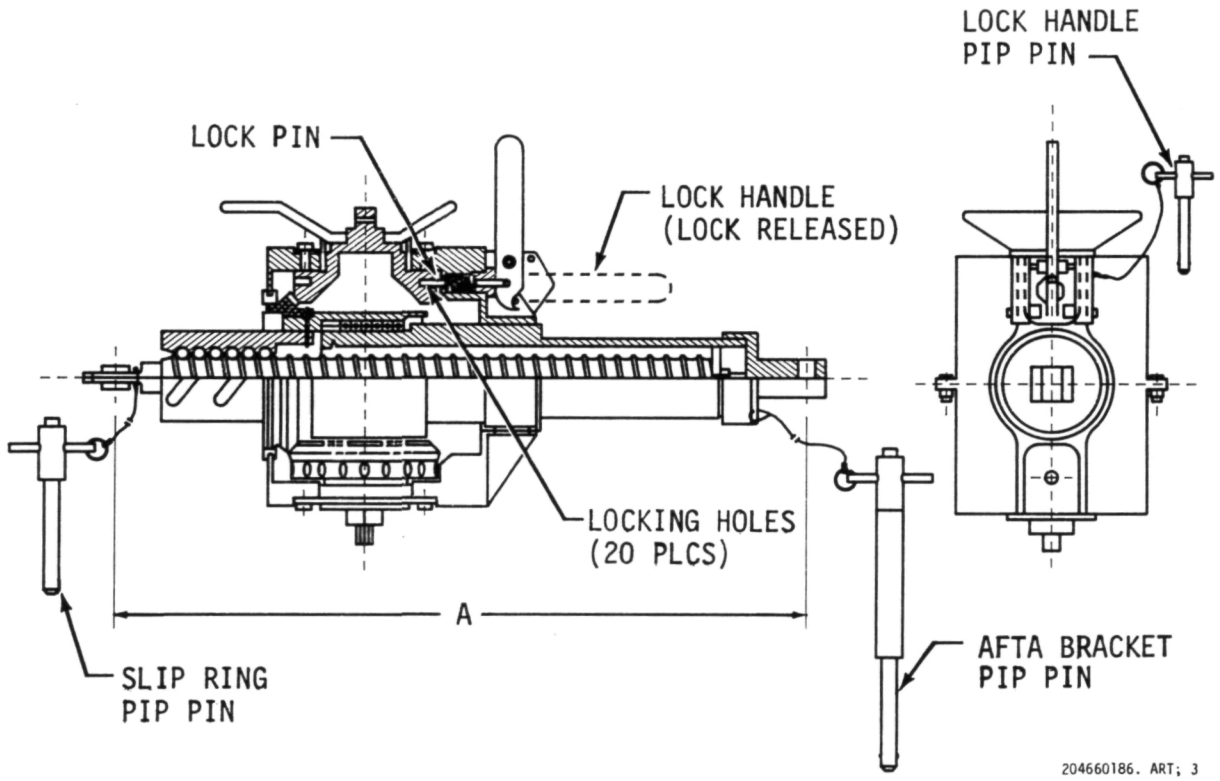
CONTACTS

Operational: S. Boyd, DF42, (713) 483-1755
Technical: Boeing/Seattle
Source: Boeing/Seattle

MANUAL AFT FRAME TILT ACTUATOR

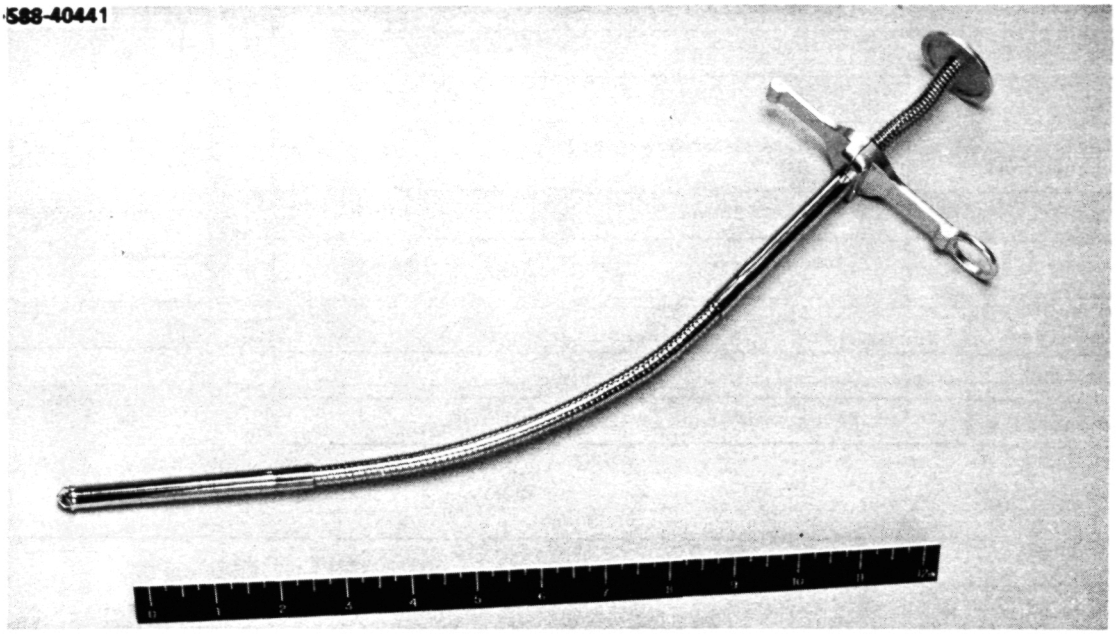
Technical Information	
Part number	Not available
Weight	40 lb
Load capability (locked)	±11,300 lb
Load capability (operating)	1500 lb (12.5 lb applied with 12-in. wrench)
Extension ratio	0.473 in. per handwheel rev
IUS elevation vs. shaft extension	6.75° per 1 in. travel
Temperature range	-10° to +25° F (operational)
Availability	Flight specific

Dimensional Data	
A	19.93 in. (retracted) 30.69 in. (extended)



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

MECHANICAL FINGER, EVA



OVERVIEW

The EVA mechanical finger is designed for retrieving loose screws or other small items which are out of reach or in an inaccessible area. The tool has been developed for use in the Hubble Space Telescope (HST) program.

OPERATIONAL COMMENTS

The EVA mechanical finger assembly consists of a modified finger ring, a flexible arm, and a knob. By positioning the knob in the palm and grabbing the tether ring handle with the fingers, the crewmember pushes the knob with his/her palm. This action extends the prongs from the tip of the arm. As the knob is pulled back out, the prongs are closed up around the object being retrieved.

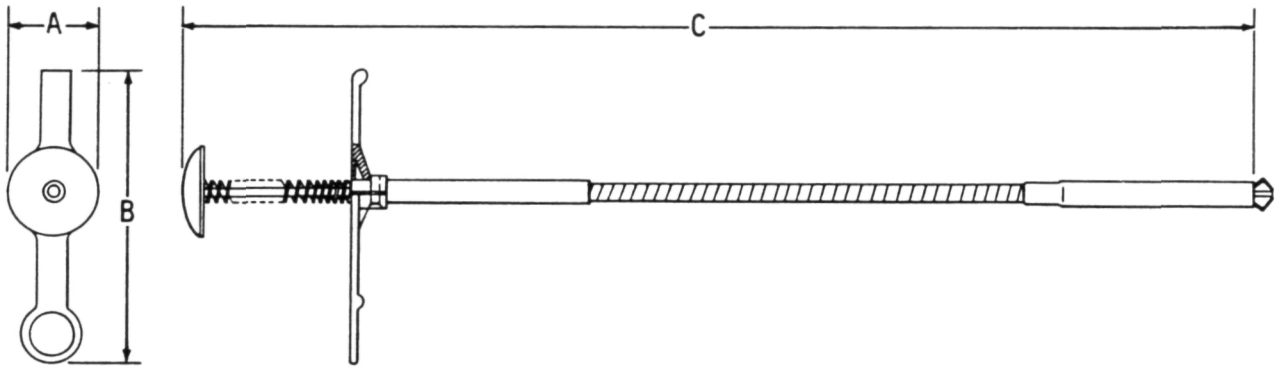
CONTACTS

Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

MECHANICAL FINGER, EVA

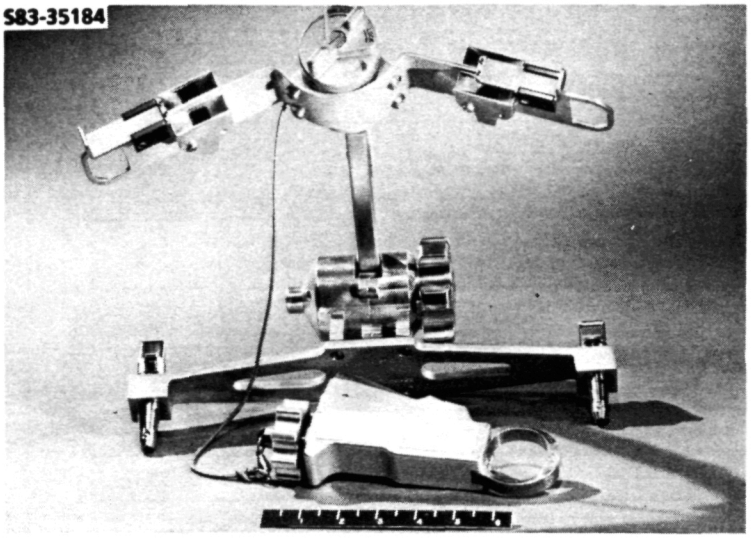
Technical Information	
Part number	10181-10018-01
Weight	0.35 lb
Material/ construction	Chrome plated carbon steel Aluminum
Temperature range	-150° to +250° F
Maximum Grasp opening	1.3 in. dia
Availability	Flight specific

Dimensional Data	
A	1.25 in.
B	4.95 in.
C	17.88 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

MINI WORK STATION



OVERVIEW

The mini work station (MWS) is a mechanical device which mounts on the front of the extravehicular mobility unit (EMU) for tool stowage and to provide a means of tether restraint for an EVA crewmember at a worksite. The MWS consists of a clutch assembly and position adjusting knob, two EMU attachment points (pip pins), a work tether and end effector, a tether retraction assembly, a T-bar, two D-rings, and four caddy attach points. The T-bar incorporates the work tether and tether D-rings. The tether is a 4-foot, self-retracting cord with a multipurpose end effector. The tether is released and locked by means of a lever on top of the reel case.

OPERATIONAL COMMENTS

The MWS is mounted on the hard upper torso of the EMU. The crewmember attaches the end effector, positions himself as desired, then locks the tether in place. The position adjusting mechanism attaches the T-bar to the MWS attaching bracket and allows the T-bar to be pivoted away from the EMU up to 170° and secured in the desired position. Two MWS's are part of the normally manifested STS equipment. They are stowed in the starboard provisions stowage assembly (PSA).

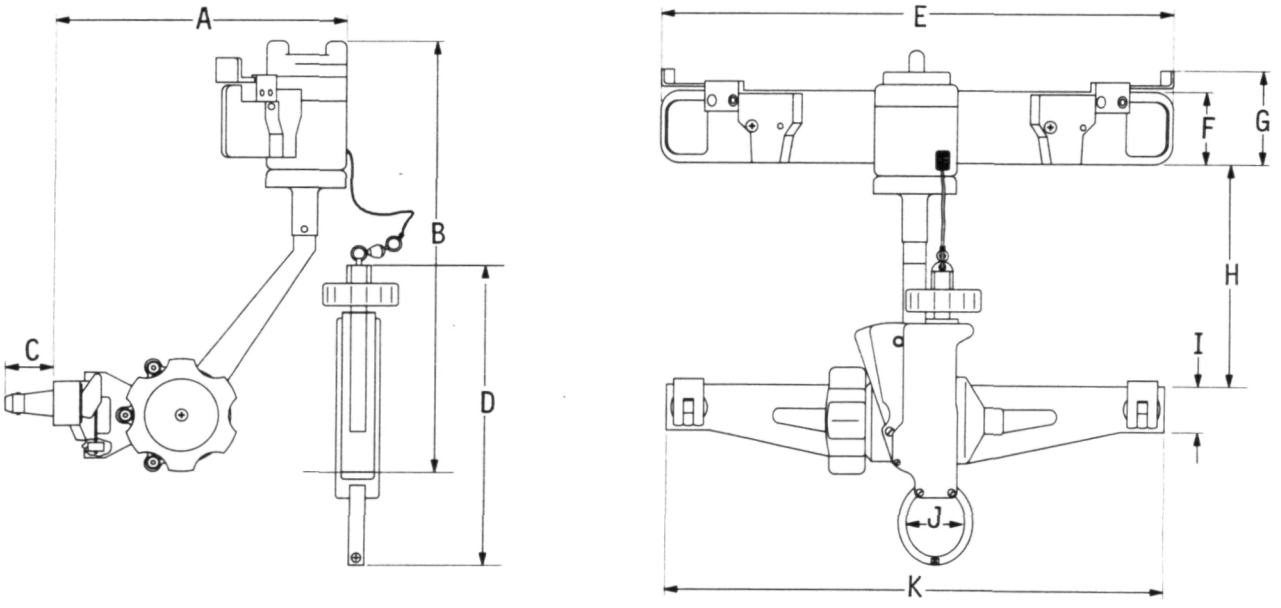
CONTACTS

Operational: C. H. Armstrong, NASA/DF4, (713) 483-2588
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: M. Withey, ILC Space Systems, (713) 488-9080

MINI WORK STATION

Technical Information	
Part number	10150-10050-06
Weight	7.85 lb
Material	Aluminum Lubricant - Molykote 321R Tether cord - PBI
Force/torque	Tether clutch will slip at 75 lb force Tether cord breakpoint - 80 lb (ave.)
Temperature range	-200° to 250° F (operational)
End effector maximum opening	1.25 in.
Quantity flown	Two in the starboard PSA
Availability	Standard

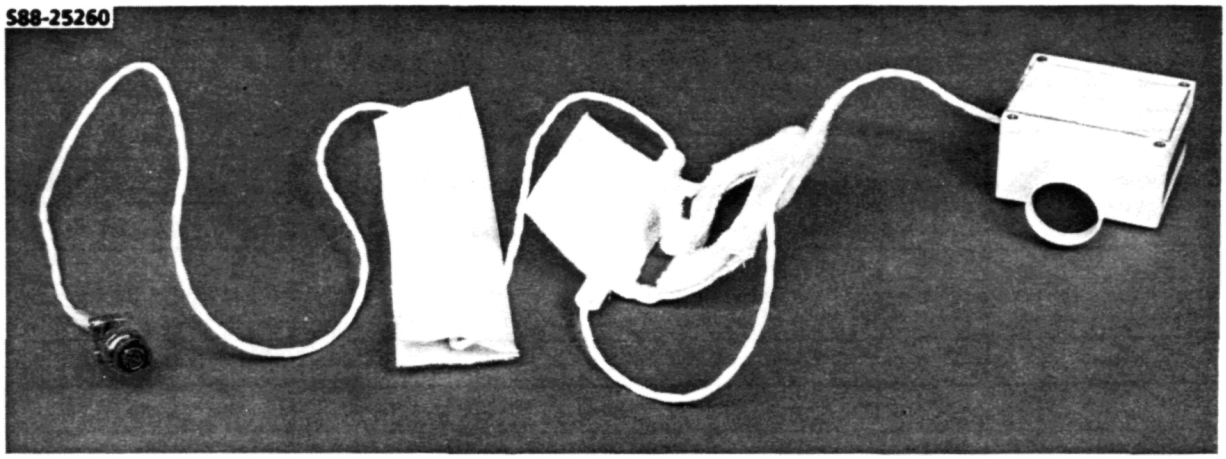
Dimensional Data	
A	7.87 in.
B	11.75 in.
C	1.30 in.
D	8.20 in.
E	14.38 in.
F	2.12 in.
G	2.94 in.
H	6.15 in.
I	1.20 in.
J	1.75 in.
K	13.70 in.



204660086.ART, 2

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

MMU 35-mm CAMERA ACTUATOR AND CABLE



OVERVIEW

The manned maneuvering unit (MMU) 35-mm camera actuator, also known as the 35-mm camera remote control assembly, provides a remote method for operating a camera shutter. The actuator is an electrical switch with connecting wires to the remote control fitting on the front of a 35-mm camera.

OPERATIONAL COMMENTS

The actuator can be mounted on either side of the MMU using cable clamps and restraint straps. A 72-inch cable connects the camera with a switch attached to the MMU near the crewmember's hand.

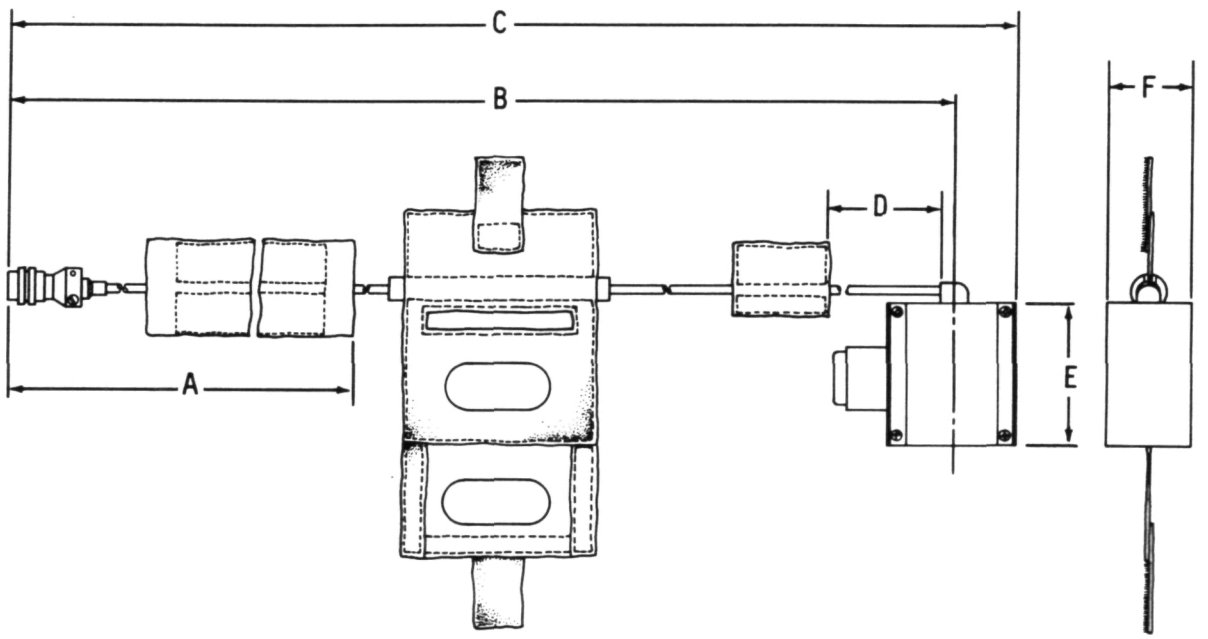
CONTACTS

Operational: R. Fullerton, NASA/DF42, (713) 483-2589
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

MMU 35-mm CAMERA ACTUATOR AND CABLE

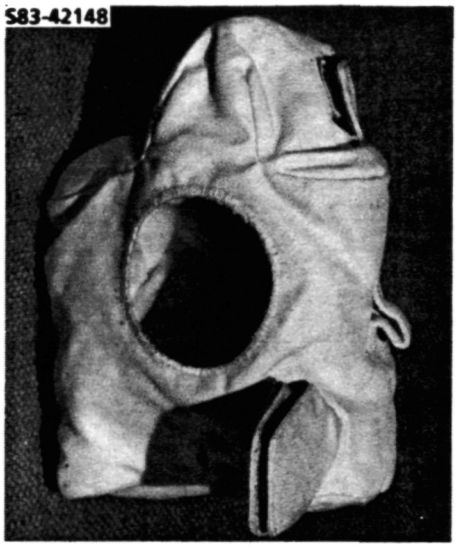
Technical Information	
Part number	SED331102479-301 SED331102479-302
Weight	11.0 oz
Material/ construction	Housing - aluminum Ortho fabric Velcro Teflon
Temperature range	-130° to +150° F
Availability	Flight specific

Dimensional Data	
A	34.38 in.
B	70.00 in.
C	71.31 in.
D	4.25 in.
E	3.00 in.
F	1.65 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

MMU 35-mm CAMERA COVER



OVERVIEW

The manned maneuvering unit (MMU) camera cover encases the MMU 35-mm camera, providing thermal protection during EVA.

OPERATIONAL COMMENTS

The MMU camera cover conforms to the shape of the camera with the aid of Velcro. The multilayer insulation cover uses 12 layers of aluminized mylar as the prime insulator. The outermost fabric is Ortho; the innermost, Teflon.

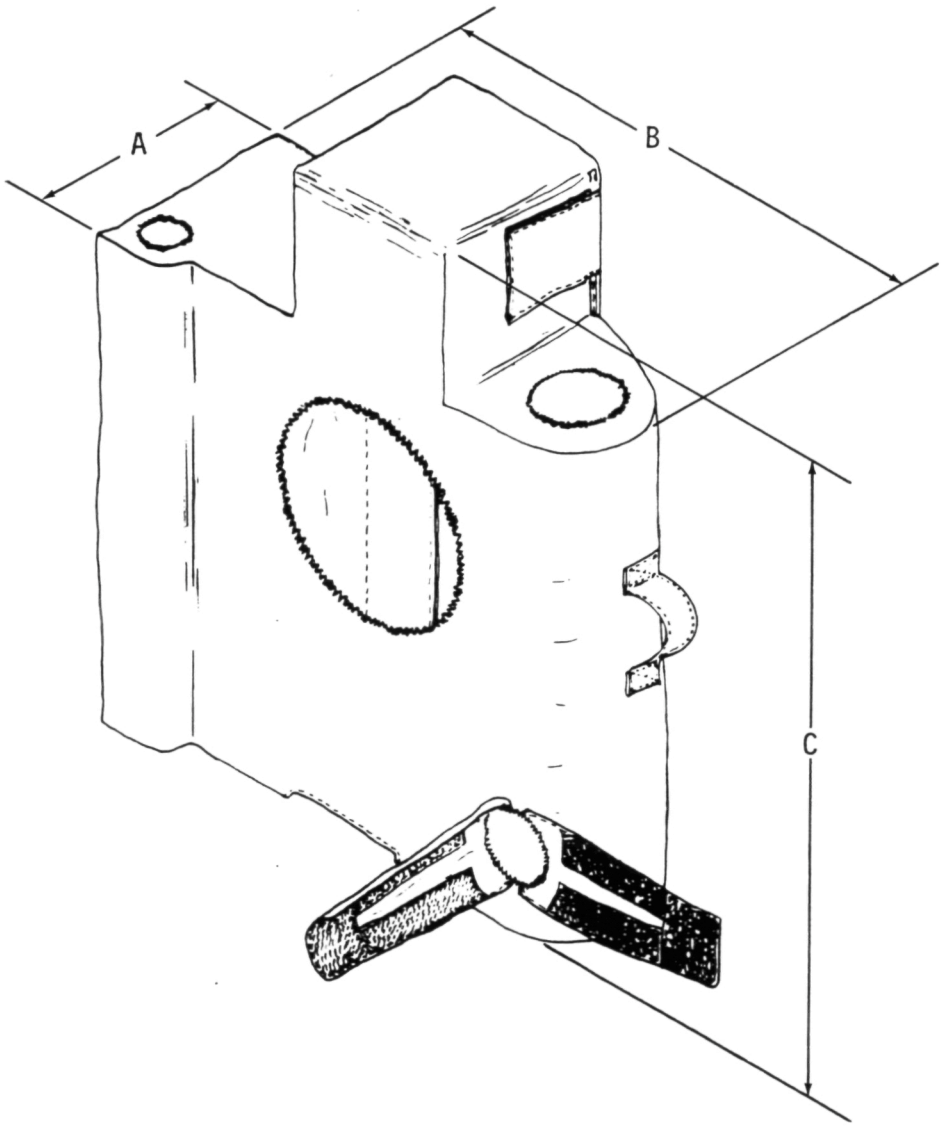
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483-2589
Technical: M. Withey, ILC Space Systems, (713) 488-9080
Source: M. Withey, ILC Space Systems, (713) 488-9080

MMU 35-mm CAMERA COVER

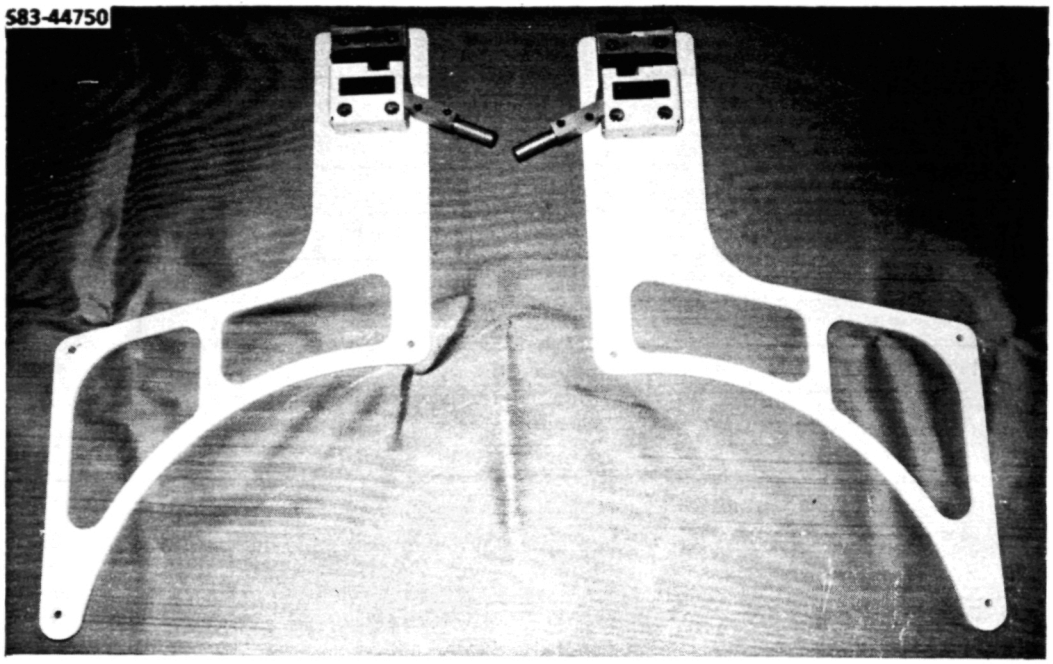
Technical Information	
Part number	10159-10012-01
Weight	6.807 oz
Quantity flown	One for STS 41-B
Stowage	Middeck locker
Availability	Flight specific

Dimensional Data	
A	2.6 in.
B	6.0 in.
C	7.5 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

MMU 35-mm CAMERA MOUNT



OVERVIEW

The manned maneuvering unit (MMU) 35-mm camera mounts are attachment points for a 35-mm camera. The mount can be attached prelaunch to either the right or left side of the MMU, depending upon the stowage position of the MMU in the payload bay.

OPERATIONAL COMMENTS

The mount is bolted to a bracket extending from the MMU, as shown in the picture. The 35-mm camera adapter slides into the mount and is locked in place by engaging a spring mechanism in the mount assembly.

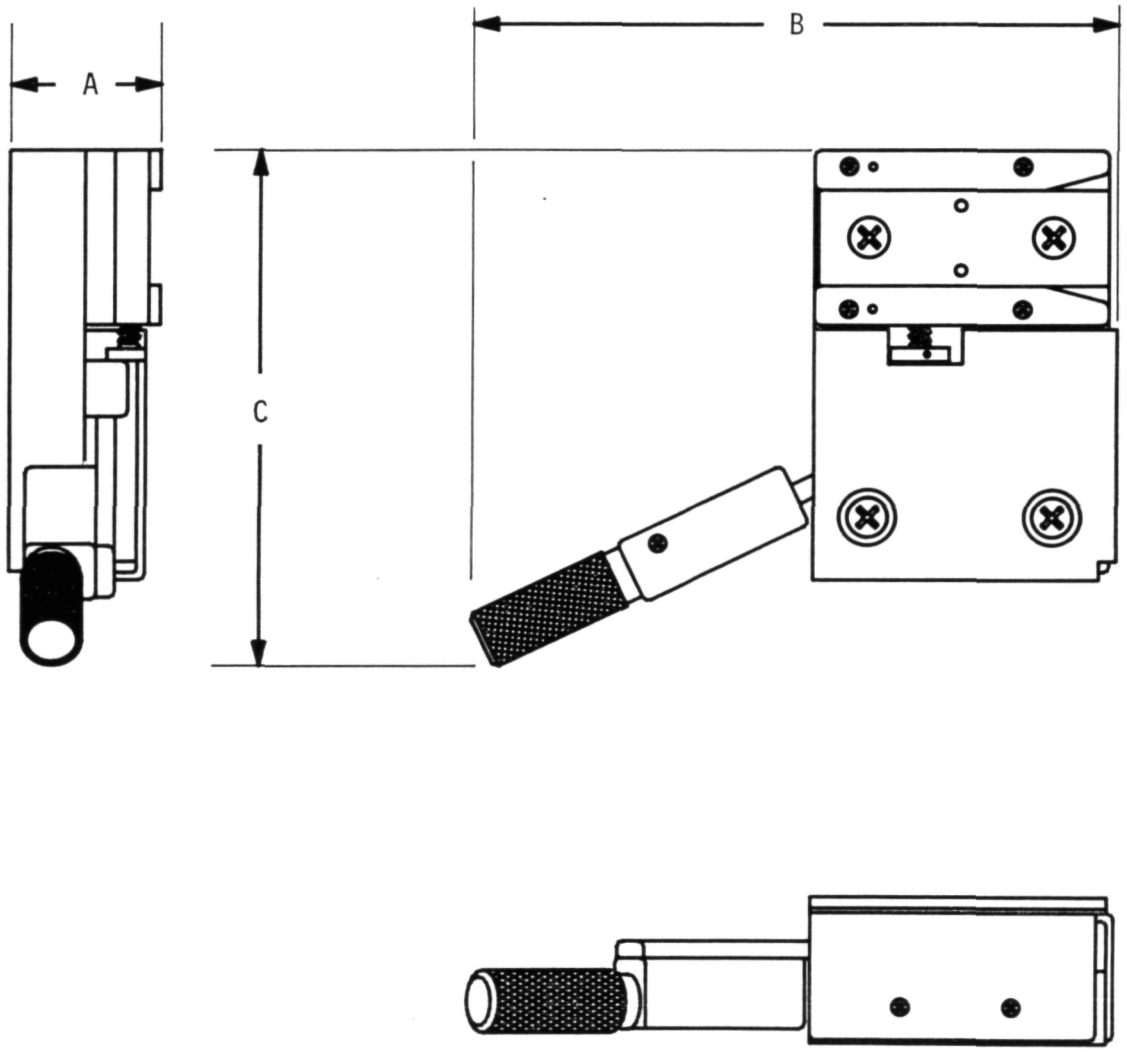
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483-2589
Technical: M. Withey, ILC Space Systems, (713) 488-9080
Source: M. Withey, ILC Space Systems, (713) 488-9080

MMU 35-mm CAMERA MOUNT

Technical Information	
Part number	SED33102490-301, -302
Weight	0.5 lb
Material	Aluminum
Quantity flown	One per MMU
Stowage	MMU
Availability	Flight specific

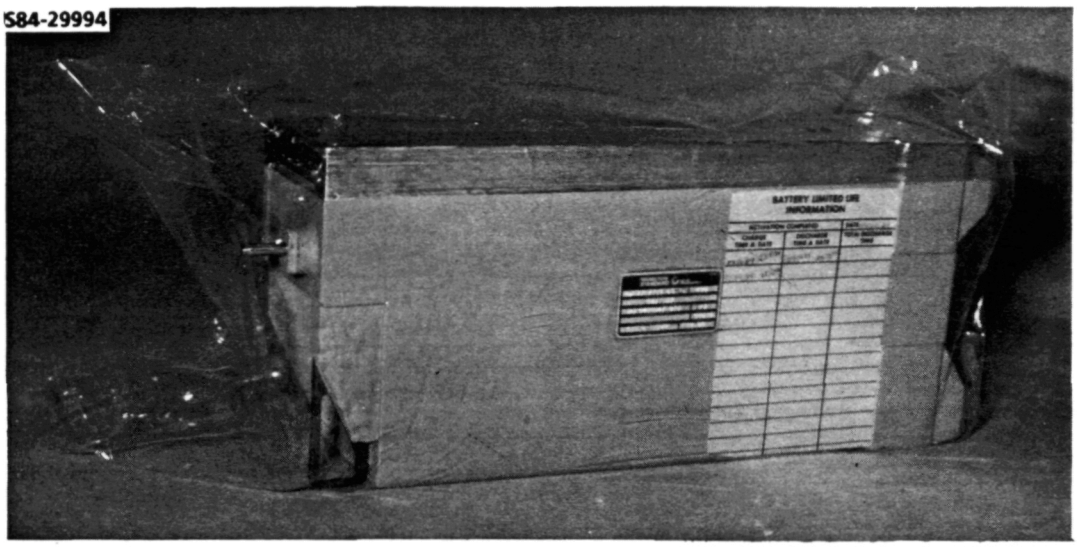
Dimensional Data	
A	1.02 in.
B	4.35 in.
C	3.73 in.



204660087.ART;2

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

MMU BATTERY



OVERVIEW

All manned maneuvering unit (MMU) power is provided by two MMU batteries installed on the front-facing vertical surface of the MMU center structure. Two spare batteries are carried on the Orbiter. Each battery is a silver-zinc (Ag-Zn) oxide 16.8-volt battery consisting of 11 series-connected cells. The MMU and extravehicular mobility unit (EMU) batteries are functionally interchangeable for use in the MMU. The MMU battery, however, has never been used as an EMU battery. The MMU battery has a tether ring and a heavier case and latch pin. The battery compartment of the MMU has a fabric thermal cover.

OPERATIONAL COMMENTS

Electrical servicing of the MMU includes replacement of the two batteries. The useful life of the battery is 15 years when stored dry and 135 days when activated. During the wet life, the battery is capable of eight charge/discharge cycles where the charge cycle spans 16 hours and the depth of discharge is 365 W/hr.

For MMU flights, two spare MMU batteries are stowed in a middeck locker and are transferred to the worksite in an MMU battery transfer bag. The MMU batteries can be charged either in the EMU as EMU batteries or by using MMU battery recharge cables, which can be connected directly to the airlock service and cooling umbilicals (SCU's).

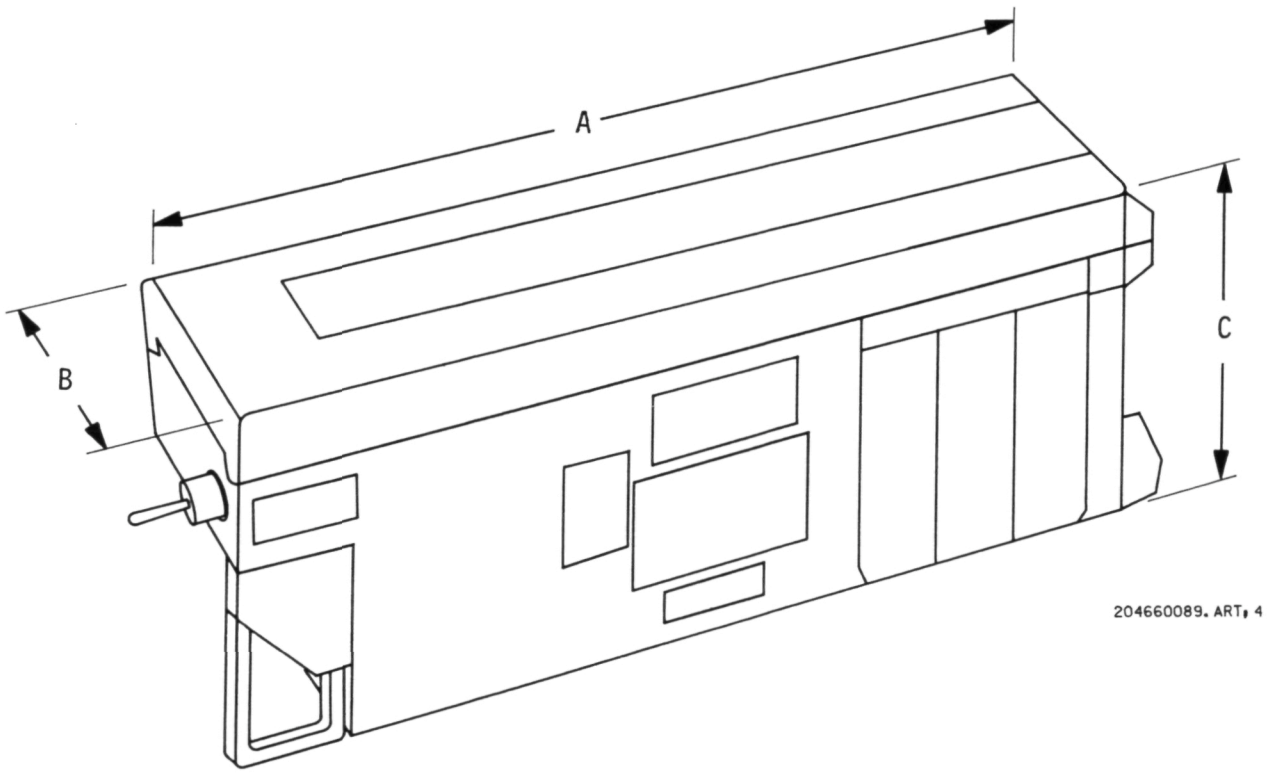
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483-2589
Technical: W. Burton, NASA/EC6, (713) 483-9251
Source: S. Curtis, Martin Marietta, Denver, CO, (303) 977-4846

MMU BATTERY

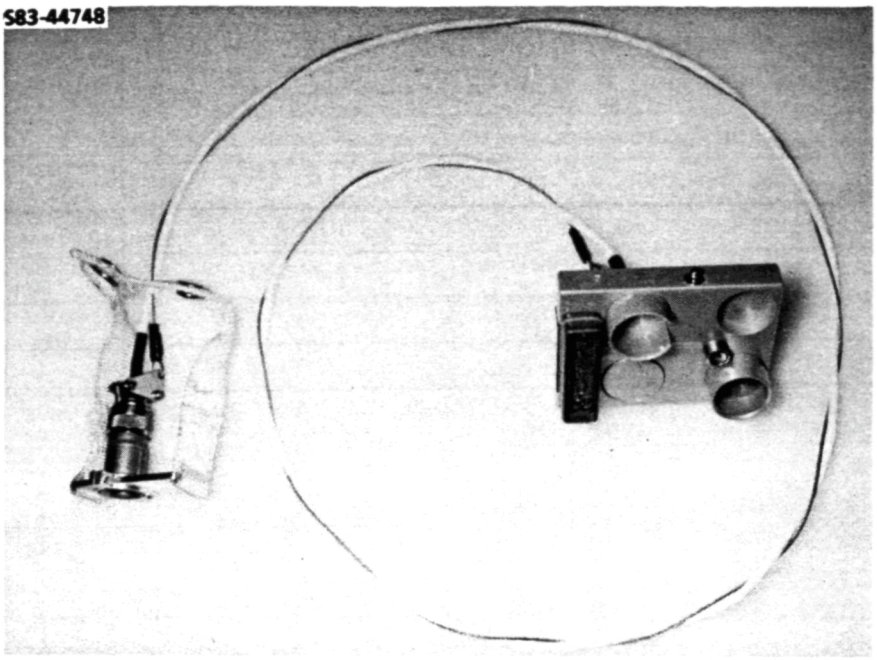
Technical Information	
Part number	SED13101573
Weight	9.1 lb activated
Material/construction	Battery - Ag-Zn oxide, KOH electrolyte Case - aluminum Pressure relief valve to prevent loss of electrolyte into space in case of disc rupture on individual cells
Battery life	15 yr dry, 135 days activated, 26.6 A-hr 8 charge/recharge cycles
Nominal voltage	16.8 ± 0.8 V with load; 20.5 V without load
Quantity flown	Two on each MMU plus two spares
Stowage	Spares in a middeck locker
Availability	Flight specific

Dimensional Data	
A	10.0 in.
B	3.0 in.
C	5.0 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

MMU BATTERY RECHARGE CABLE



OVERVIEW

The manned maneuvering unit (MMU) battery recharge cable is used to recharge the MMU battery.

OPERATIONAL COMMENTS

The MMU battery recharge cable consists of a connector plug, which interfaces with the MMU battery, and a connector, which hooks up to an EMU servicing and cooling umbilical (SCU) in the airlock, connected by a four-conductor cable. Two straps on either side of the battery connector plug secure the plug to the battery. A 48-inch steel cable is entwined around the conductor cable to provide tension relief for the assembly. A replaceable fuse is planned as a future addition to the basic design.

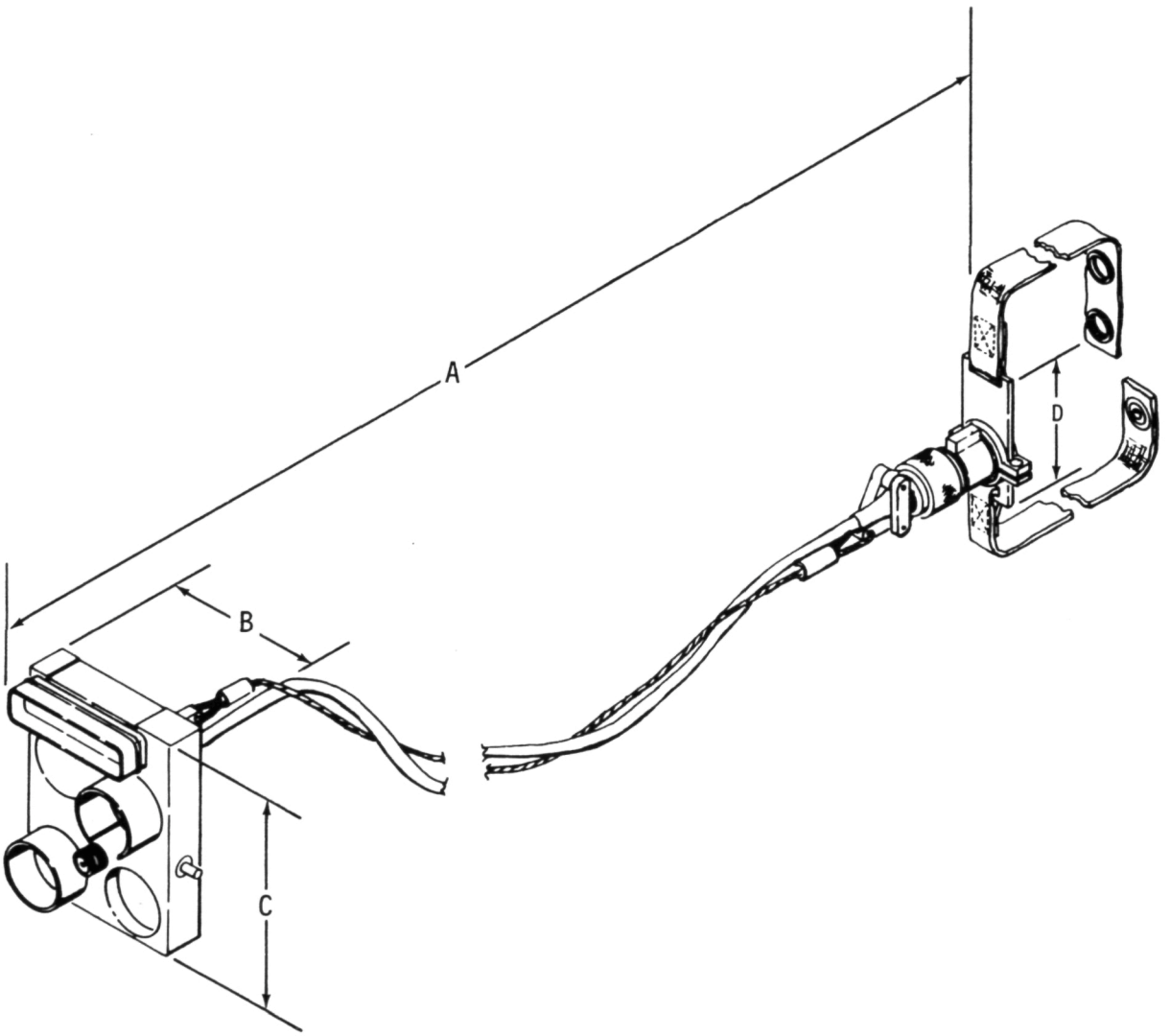
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483-2589
Technical: C. E. Whitsett, NASA/EC1, (713) 483-9111
Source: M. Withey, ILC Space Systems, (713) 488-9080

MMU BATTERY RECHARGE CABLE

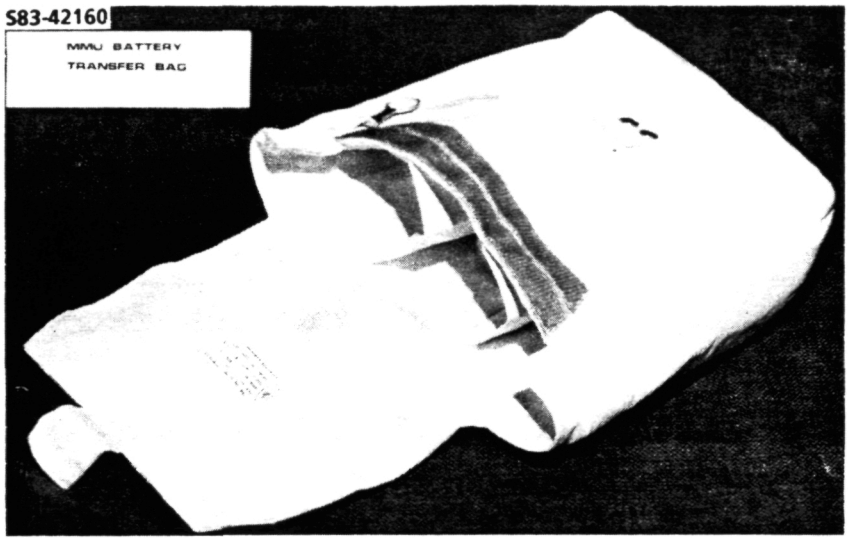
Technical Information	
Part number	10159-10005-01
Weight	1.12 lb
Material	Cable - aluminum alloy
Quantity flown	One for STS 51-A
Stowage	Middeck locker
Availability	Flight specific

Dimensional Data	
A	52.760 in. true length
B	2.875 in.
C	3.800 in.
D	2.300 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

MMU BATTERY TRANSFER BAG



OVERVIEW

The manned maneuvering unit (MMU) battery transfer bag is a multiple-layer insulated bag used for the transfer and temporary stowage of up to three MMU batteries in the cargo bay.

OPERATIONAL COMMENTS

The MMU battery transfer bag is insulated with an alternating layup of aluminized mylar and polyester scrim materials covered by Ortho. These protect the batteries from the effects of temperature extremes. Three separate compartments contain the batteries, and a Velcro restraint strap on each compartment keeps the batteries in the bag. A guide pull strap on one side provides one tethering point for the bag. A unidirectional snap strap can be used as a handle or as a wraparound strap for securing the bag.

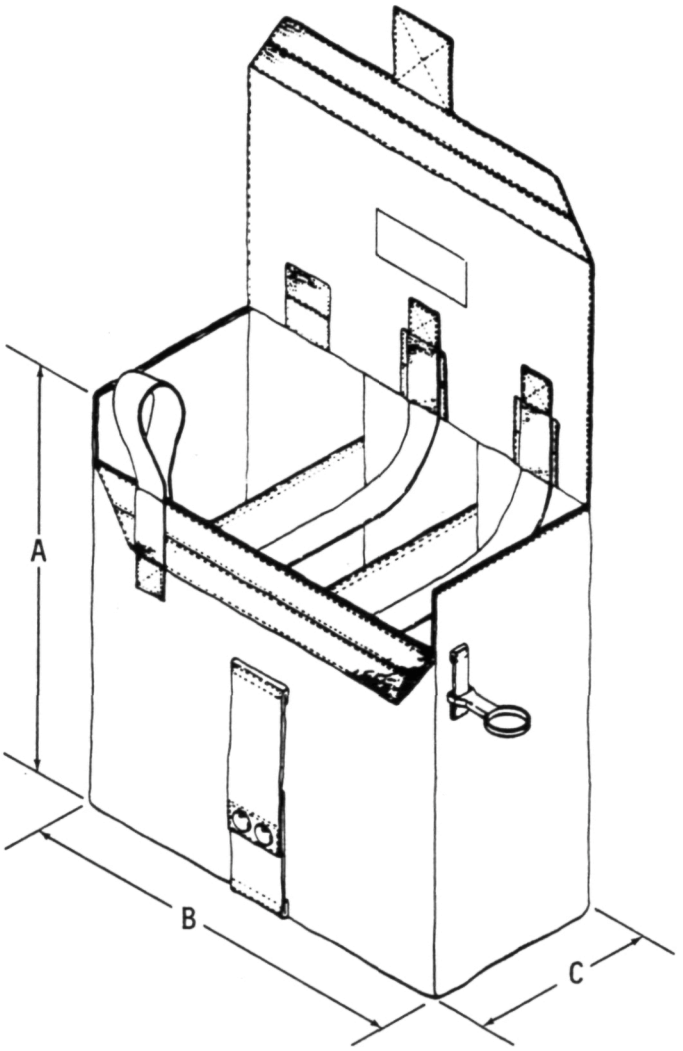
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483-2589
Technical: R. J. Marak, NASA/EC5, (713) 483-9114
Source: M. Withey, ILC Space Systems, (713) 488-9080

MMU BATTERY TRANSFER BAG

Technical Information	
Part number	10159-10003-01
Weight	1.93 lb
Material	Ortho, Teflon, aluminized mylar, polyester scrim
Quantity flown	One for STS 51-A
Stowage	Middeck locker
Availability	Flight specific

Dimensional Data	
A	12.0 in.
B	11.7 in.
C	5.5 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

MMU BATTERY TRANSFER STRAP

OVERVIEW

The manned maneuvering unit (MMU) and extravehicular mobility unit (EMU) batteries are identical except that the MMU battery casing is sturdier and has a built-in tether attachment point. The MMU battery transfer strap permits an EMU battery to be used as an MMU battery. This strap fits around the EMU battery to provide a tether point for transporting the battery to and from the MMU and securing the battery during removal and replacement. The strap is constructed of 1-inch-wide Kevlar webbing, fastened with a metal snap.

OPERATIONAL COMMENTS

The MMU battery transfer strap remains on the EMU battery while the battery is installed on the MMU. A metal bracket, securely sewn to and threaded onto the transfer strap, serves as a tether point. An EMU battery used in the MMU should not remain in the MMU for landing because of structural concerns.

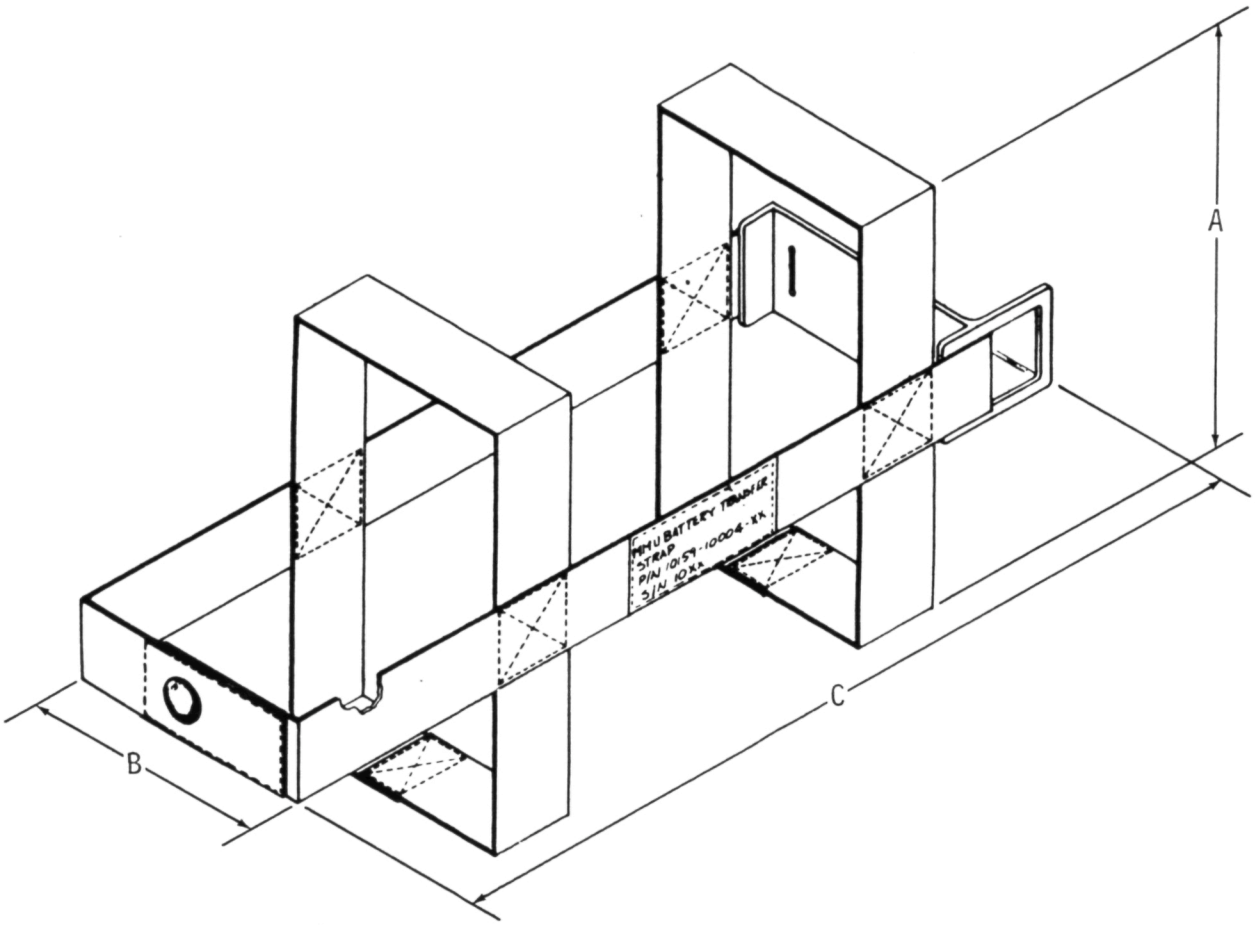
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483-2589
Technical: C. E. Whitsett, NASA/EC1, (713) 483-9111
Source: M. Withey, ILC Space Systems, (713) 488-9080

MMU BATTERY TRANSFER STRAP

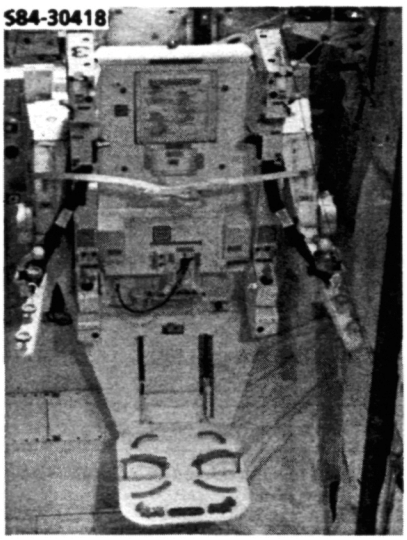
Technical Information	
Part number	10159-10004-01
Weight	0.16 lb
Material	Kevlar webbing 1 in. wide
Availability	Flight specific

Dimensional Data	
A	5.000 in.
B	2.875 in.
C	10.250 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

MMU FLIGHT SUPPORT STATION



OVERVIEW

The manned maneuvering unit (MMU) flight support station (FSS) is a servicing and mounting interface structure between the MMU and Orbiter. The FSS provides a stowage port and GN_2 recharge of the MMU. Thermal control of the FSS is provided by extensive use of multilayer insulation (MLI) and by heaters on selected FSS propulsion components. A shock isolation system attenuates the MMU/FSS random vibrations to an acceptable level.

OPERATIONAL COMMENTS

The FSS provides MMU stowage, MMU GN_2 recharge, and power for five MMU heaters when stowed. Crewmember donning and doffing and MMU/FSS restowing are assisted by various devices on the FSS and MMU. By using the FSS handrails, mushroom grips, foot restraints, and donning straps, the EVA crewmember backs into and dons the MMU. The FSS latch release lever is then used to disconnect the MMU from the FSS. Restowing of the MMU is aided by various ramping designs. The rear of the MMU is ramped on the bottom and sides. The FSS handrails converge to guide the astronaut and MMU into the FSS. The FSS seat ramps the MMU to the proper height. A spring-loaded latch on each side of the FSS secures the MMU to the FSS.

The FSS is mounted on the port or starboard side of the Orbiter cargo bay near the EVA airlock.

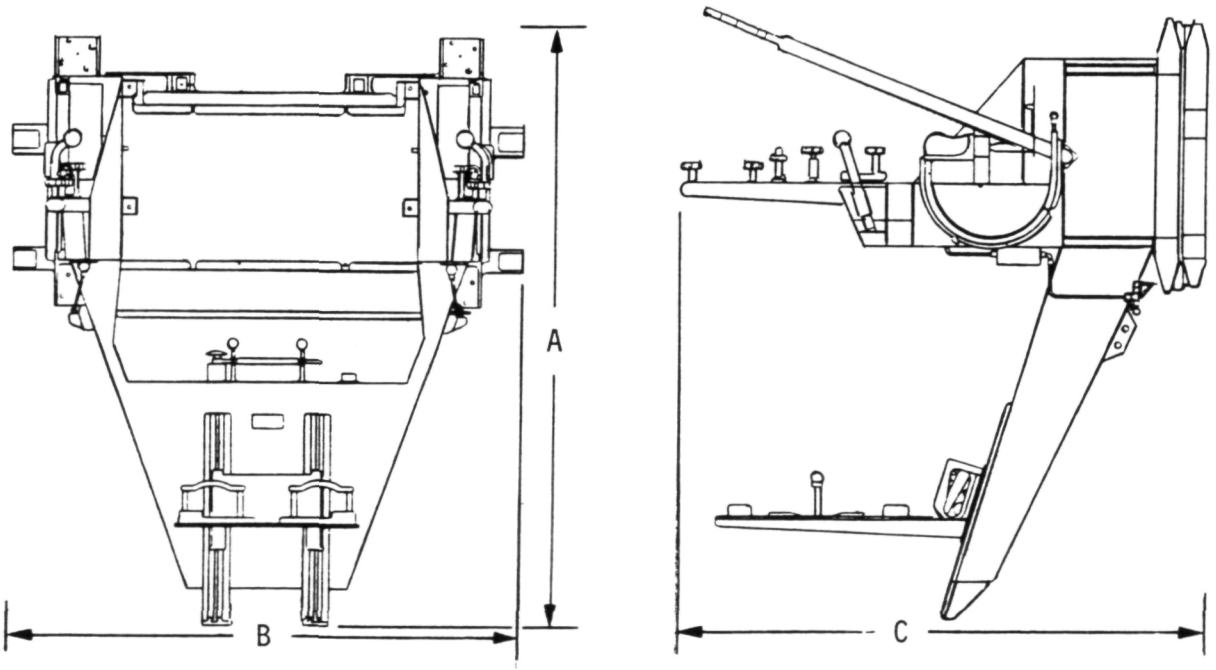
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483-2589
Technical: C. E. Whitsett, NASA/EC1, (713) 483-9111
Source: S. Curtis, Martin Marietta, Denver, CO, (303) 977-4846

MMU FLIGHT SUPPORT STATION

Technical Information	
Part number	852MM000000V
Weight	253 lb
Material/construction	Structure - aircraft-style aluminum sheet metal Handrails and foot restraint platform - fiberglass Exterior paint - white Interior surfaces - low emissivity coating Multilayer insulation - 10 layers of 1/4-mil aluminized (both sides) mylar with Dacron net separators Heaters on selected propulsion components Shock isolation system - attenuates FSS/MMU random vibrations
Foot platform	Adjustable over 14-in. range in 1-in. increments
Mounting	On port or starboard side of cargo bay near EVA airlock (bay 1)
Availability	Flight specific

Dimensional Data	
A	67.0 in.
B	57.0 in.
C	57.9 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

MMU FSS CONTINGENCY TOOL

S88-40462

OVERVIEW

The manned maneuvering unit (MMU) flight support station (FSS) contingency tool is stowed on the MMU FSS for use as needed. The tool is a 9/16-inch open end wrench at one end and a ratchet for a 5/16-inch socket at the other. The original tool (10159-10006-01) has been replaced by an improved model (10159-10045-01).

OPERATIONAL COMMENTS

The MMU FSS contingency tool is approximately 13 inches long and has two tether points. The ratchet has a mushroom-shaped spinner on one side to facilitate use by the gloved crewmember. A clutch is attached to the ratchet and will slip in the clockwise direction when a maximum force is applied. The clutch does not slip in the counterclockwise direction. The ratchet is reversible. The original flexible socket has been replaced by a deep well socket, and torque limit has been doubled in the improved clutch.

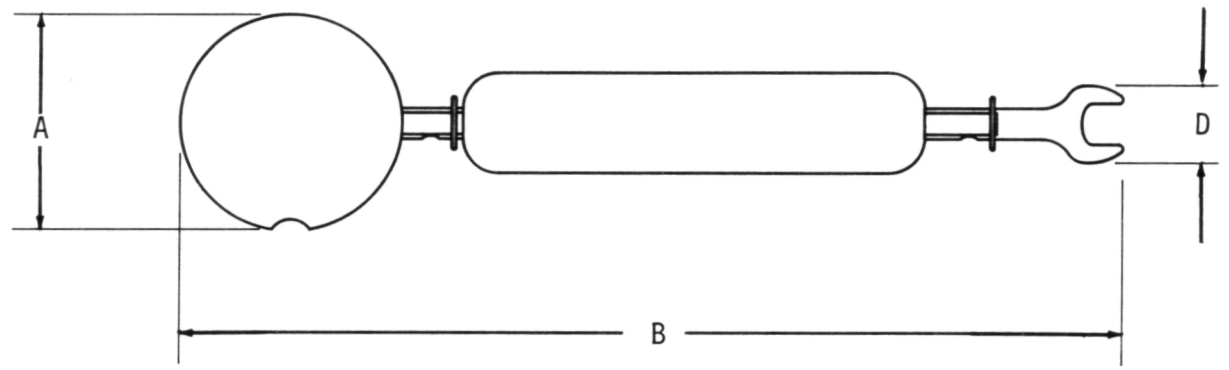
CONTACTS

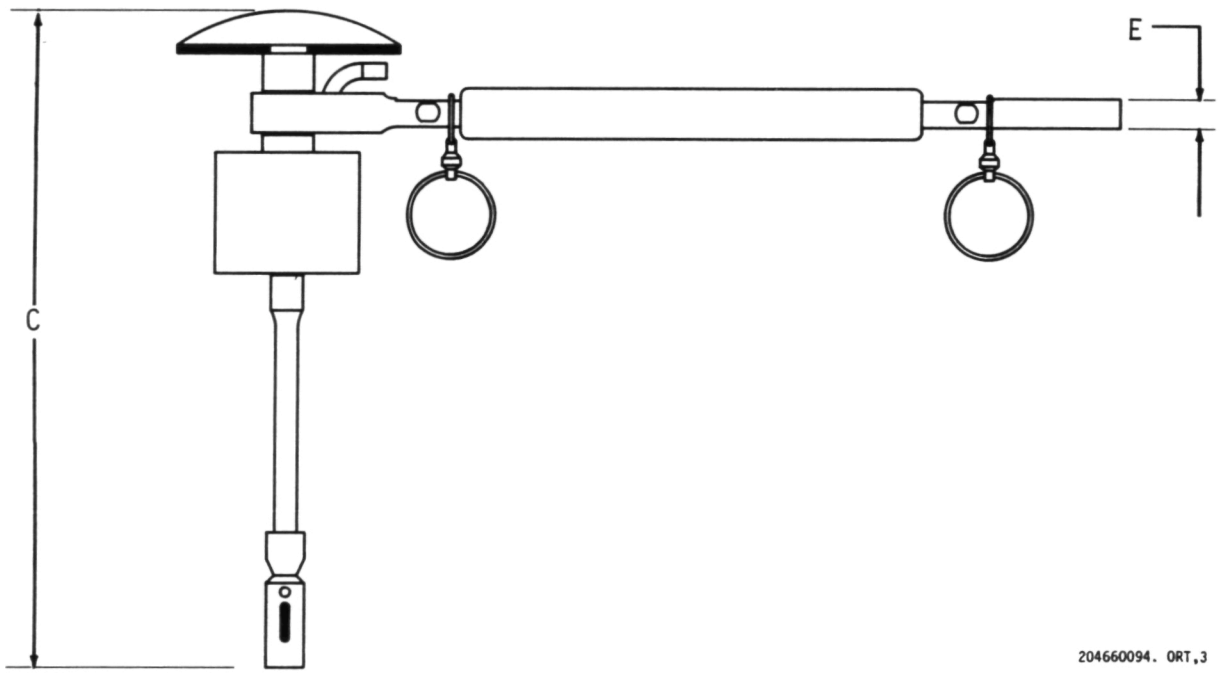
Operational: R. K. Fullerton, NASA/DF42, (713) 483-2589
Technical: C. E. Whitsett, NASA/EC1, (713) 483-9111
Source: M. Withey, ILC Space Systems, (713) 488-9080

MMU FSS CONTINGENCY TOOL

Technical Information	
Part number	10159-10045-01
Weight	1.81 lb
Material	Handle - steel, epoxy-covered Mushroom handle - aluminum
Temperature range	-100° to + 160° F (operational)
Socket depth	0.78 in.
Torque limit	140 ± 30 in-lb (clockwise direction) 190 in-lb (counter clockwise direction)
Stowage	MMU FSS
Availability	Flight-specific

Dimensional Data	
A	3.00 in.
B	13.20 in.
C	10.40 in.
D	1.10 in.
E	0.35 in.

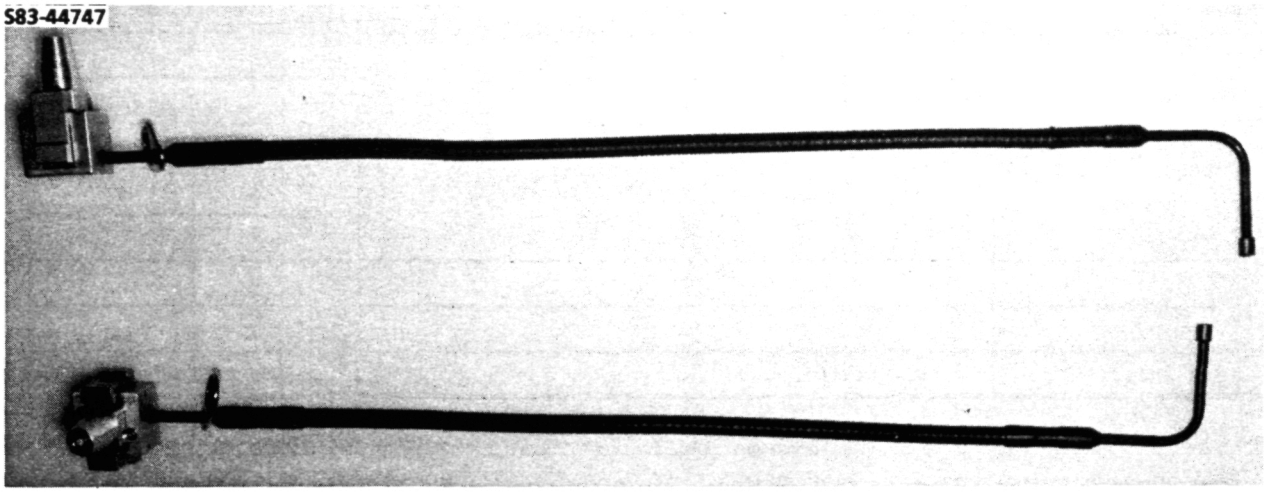




204660094. ORT,3

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

MMU THRUSTER CUE LIGHT EXTENDER



OVERVIEW

The manned maneuvering unit (MMU) thruster cue light extender is a flexible fiber-optic cable with a metal plug at one end and a light outlet at the other end. These light extenders are used because the original cue lights, which are recessed in holes in the sides of the MMU towers, are not readily visible by the EVA crewmember.

OPERATIONAL COMMENTS

The thruster cue light extenders are plugged in by the EVA crewmember before the MMU is donned. They plug into special sockets on the inside of the MMU towers near the original cue lights. The bendable fiber-optic cable can be positioned by the crewmember to make the lights readily visible when the MMU is donned.

The MMU has two identical, independent propulsion systems, A and B. The lights are illuminated whenever a thruster of the appropriate system is used, with the light on the crewmember's left representing system A and the one on the right representing system B.

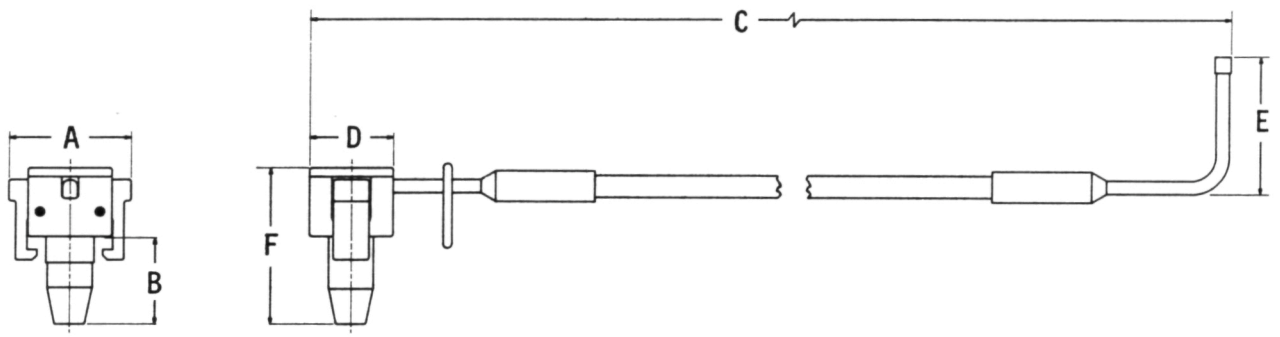
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483-2589
Technical: C. E. Whitsett, NASA/EC1, (713) 483-9111
Source: M. Withey, ILC Space Systems, (713) 488-9080

MMU THRUSTER CUE LIGHT EXTENDER

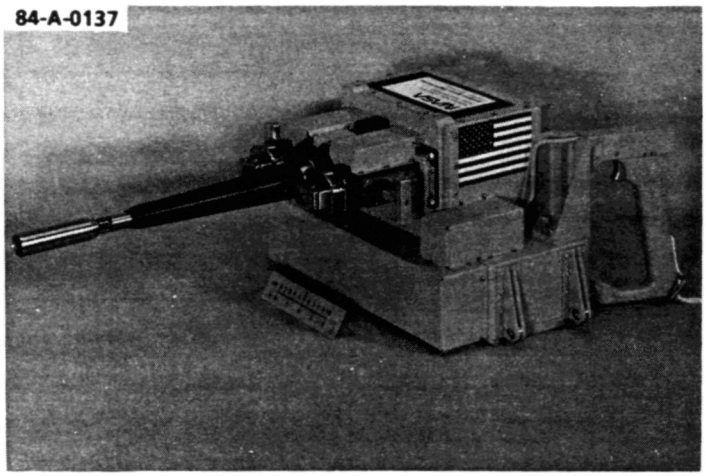
Technical Information	
Part number	10159-10017-01
Weight	0.5 lb each
Material/ construction	Extenders - fiber-optic cables covered with stiff but bendable material Plug end - metal Outlet end - metal cover
Availability	Flight specific

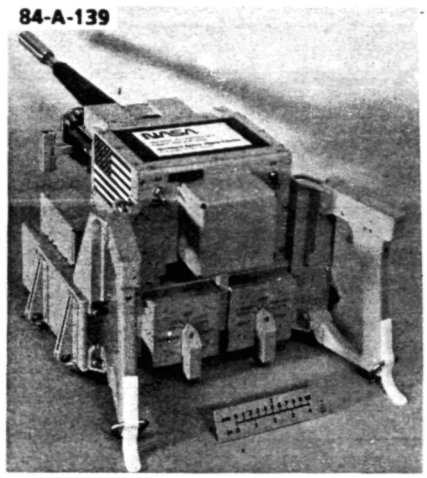
Dimensional Data	
A	1.594 in.
B	1.211 in.
C	18.500 in.
D	1.109 in.
E	2.000 in.
F	2.156 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

MODULE SERVICING TOOL





OVERVIEW

The module servicing tool (MST) is a self-contained power tool for use in installing and removing standard multimission modular spacecraft (MMS) subsystem modules to simplify on-orbit maintenance and repair operations and to reduce the time required for the performance of extravehicular activities. The MST is battery-powered and manually operated and therefore does not have any STS power or signal interfaces.

OPERATIONAL COMMENTS

The MST is an extravehicular mobility unit (EMU) battery-powered EVA tool which is designed to loosen and tighten the MMS module retention hardware to predetermined torques of up to 160 foot-pounds. A latch system secures the MST to the module and internally reacts against torques when retention hardware is driven. All operations of the MST are controlled by manual controls at the MST rear panel and trigger switches located at the right and left grip assemblies. There is a torque limit select switch which selects the desired torque for both bolt tightening and bolt loosening. Also, the MST has a bolt drive counter which provides the operator visual indication of bolt drive rotation direction and of bolt tightening completion. A separate control circuit provides power to two resistance heaters which thermostatically maintain the minimum battery temperature. Separate external heaters are required to maintain MST battery temperatures prior to EVA use. Two of these power tools were flown on STS 41-C and successfully replaced the attitude control system (ACS) module of the Solar Maximum Satellite.

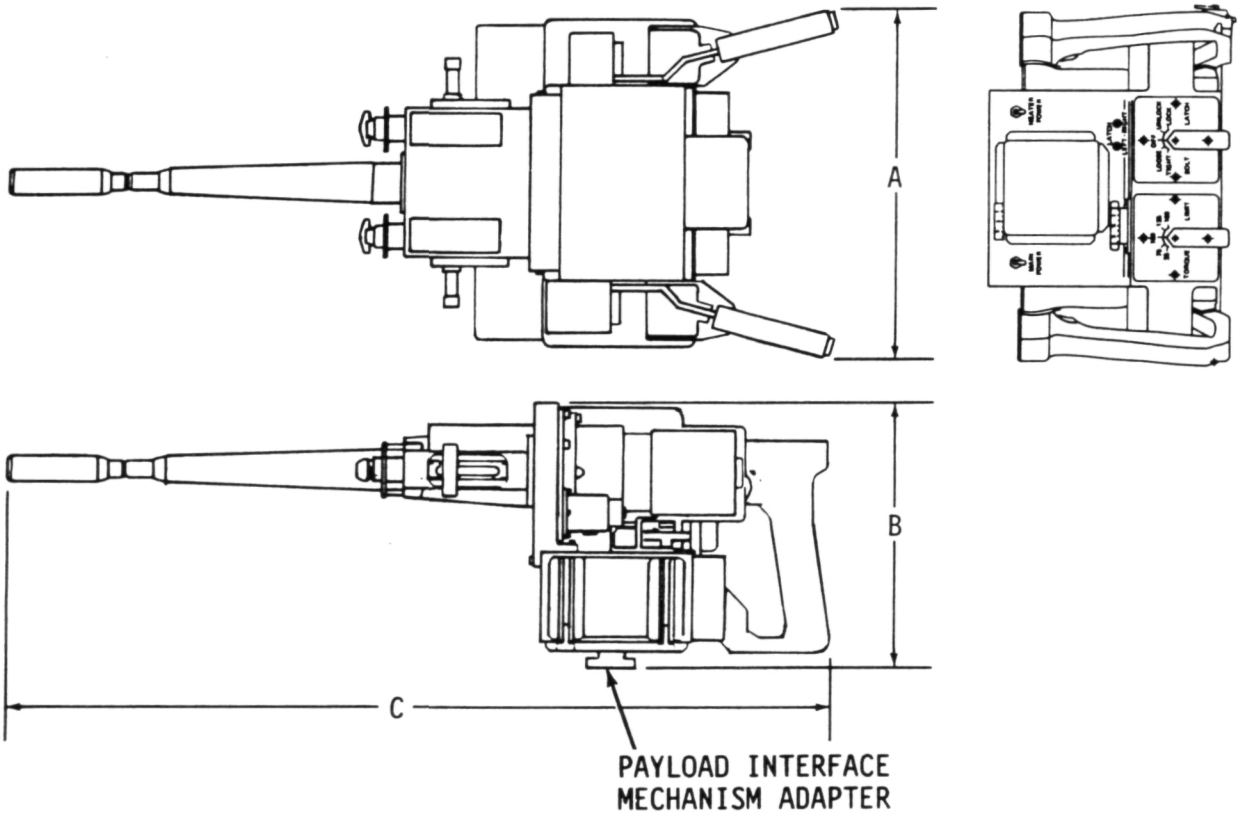
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: K. Olson, NASA/GSFC, (301) 286-3230
Source: K. Olson, NASA/GSFC, (301) 286-3230

MODULE SERVICING TOOL

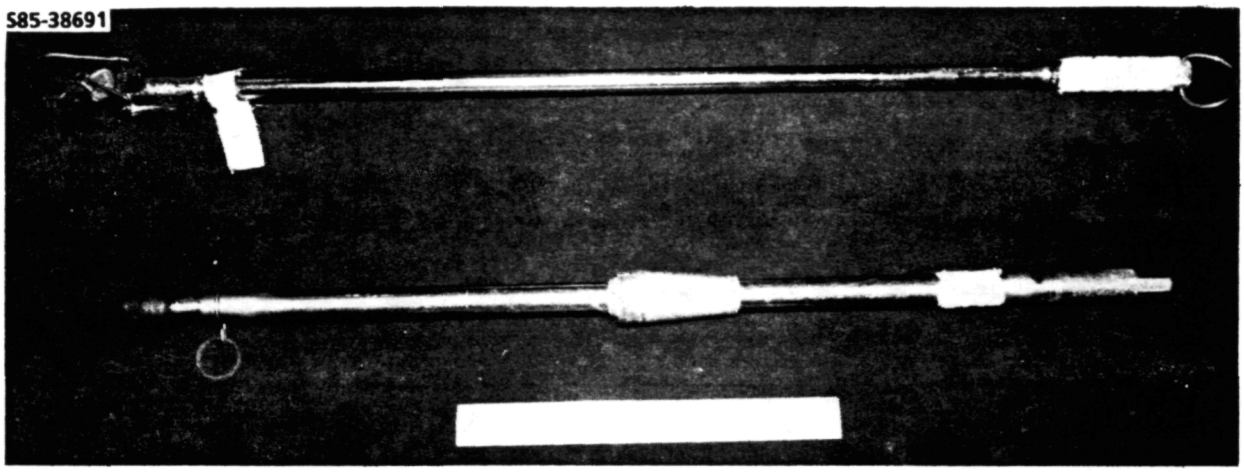
Technical Information	
Part number	GSFC 93972000002
Weight	70.5 lb
Material	Housing - not available Surface - Chemglaze blue
Torque range	Settings for 25, 75, 100, 125, and 160 ft-lb
Temperature range	-10° to 104° F
Power requirements	16.5 V EMU battery
Availability	Flight specific

Dimensional Data	
A	14.75 in.
B	14.32 in.
C	35.20 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

MST MANUAL BACKUP



OVERVIEW

The module servicing tool (MST) manual backup is a large standard 3/4-inch drive ratchet handle and extension/socket combination. The ratchet is 39 inches long, and the extension/socket combination is 32 inches long with a 3/4-inch hex head. The ratchet handle is wrapped with Velcro and has a rotating tether ring at the handle end. The extension has a rotating hand grip near the middle of the extension and a rotating tether ring near the drive end.

OPERATIONAL COMMENTS

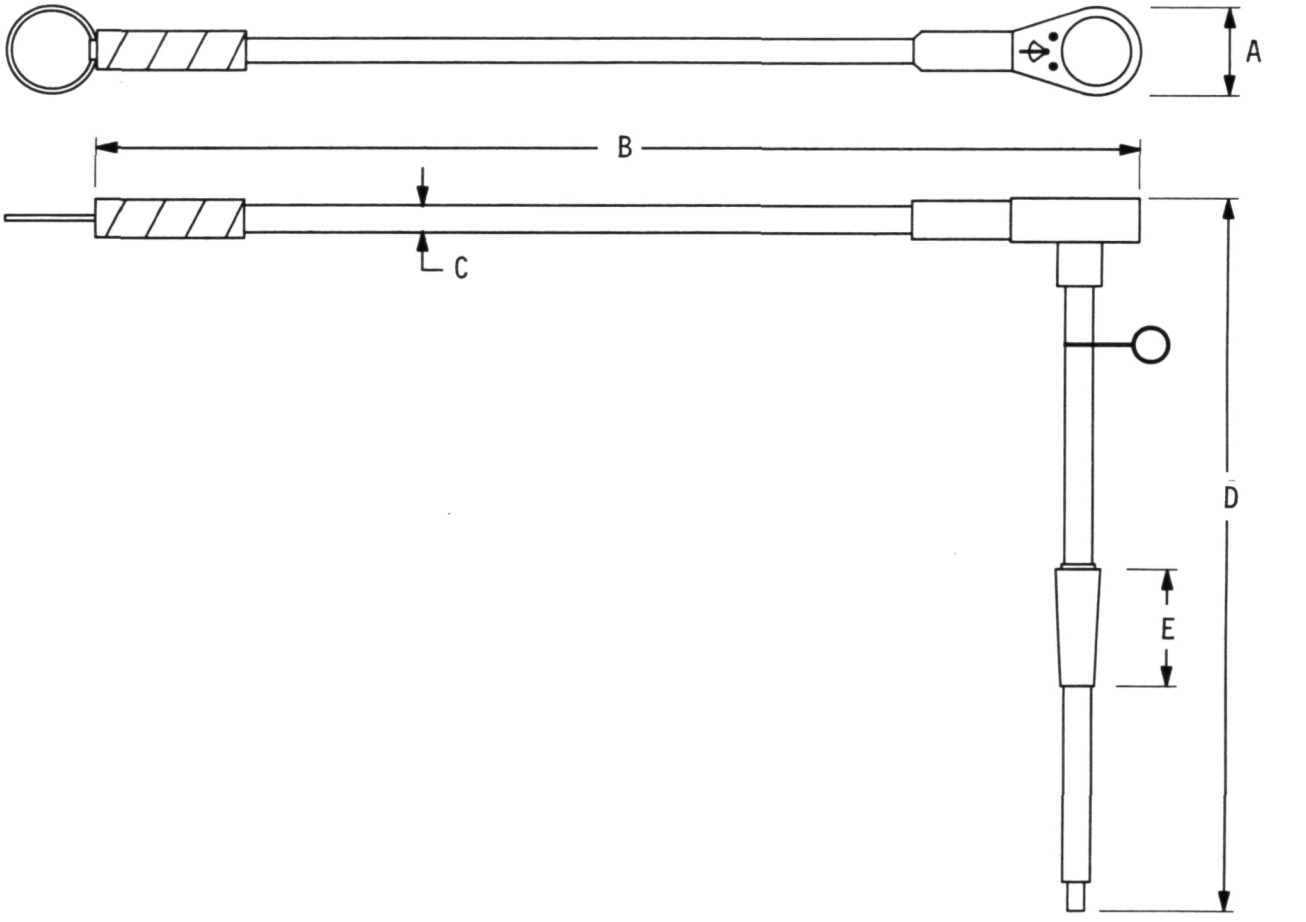
The MST manual backup tool is used only in the event of a contingency situation in which a modular jack screw cannot be released with the primary MST. It can be used as a standard ratchet-extension combination to loosen and tighten the multimission modular spacecraft module retention hardware with torques of up to 375 foot-pounds. A switch allows selection of ratcheting direction.

CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: K. Olson, NASA/GSFC, (301) 286-3230
Source: K. Olson, NASA/GSFC, (301) 286-3230

Technical Information	
Part number	Shaft - 1413466 Ratchet - 1413468
Weight	14.7 lb
Material/ construction	Ratchet - Snap-On Tool Co. #L72T Extension - Snap-On Tool Co. #GLA62 Velcro-wrapped handle, aluminum rotating hand grip, tether rings Coating - blue Chemglaze
Maximum torque	375 ft-lb
Availability	Flight specific

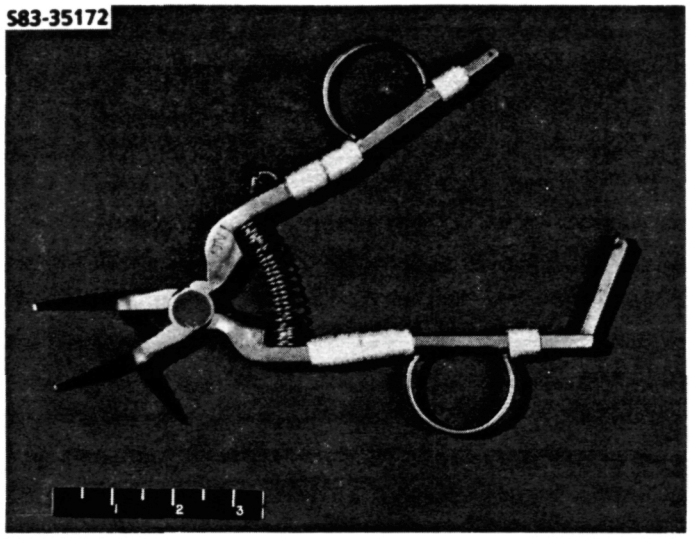
Dimensional Data	
A	3.5 in.
B	39.0 in.
C	0.8 in.
D	34.4 in.
E	4.0 in.



204660098.ART, 2

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

NEEDLE NOSE PLIERS



OVERVIEW

The needle nose pliers have a maximum opening of 2 inches, and the angle between the handles and the jaws is approximately 60°. The needle nose pliers have finger rings designed to fit the crewmember's gloved hand, a latch to hold the handle in the closed position, a spring to force the handles apart, and a ring for tether attachment.

OPERATIONAL COMMENTS

The needle nose pliers are used as a disconnect and jam removal tool. The 60° bend between handle and jaws allows easy access into tight places.

This tool is part of the normally manifested STS equipment. It is wrapped in a Velcro-lined tool caddy along with diagonal cutters and is stowed in the starboard provisions stowage assembly (PSA).

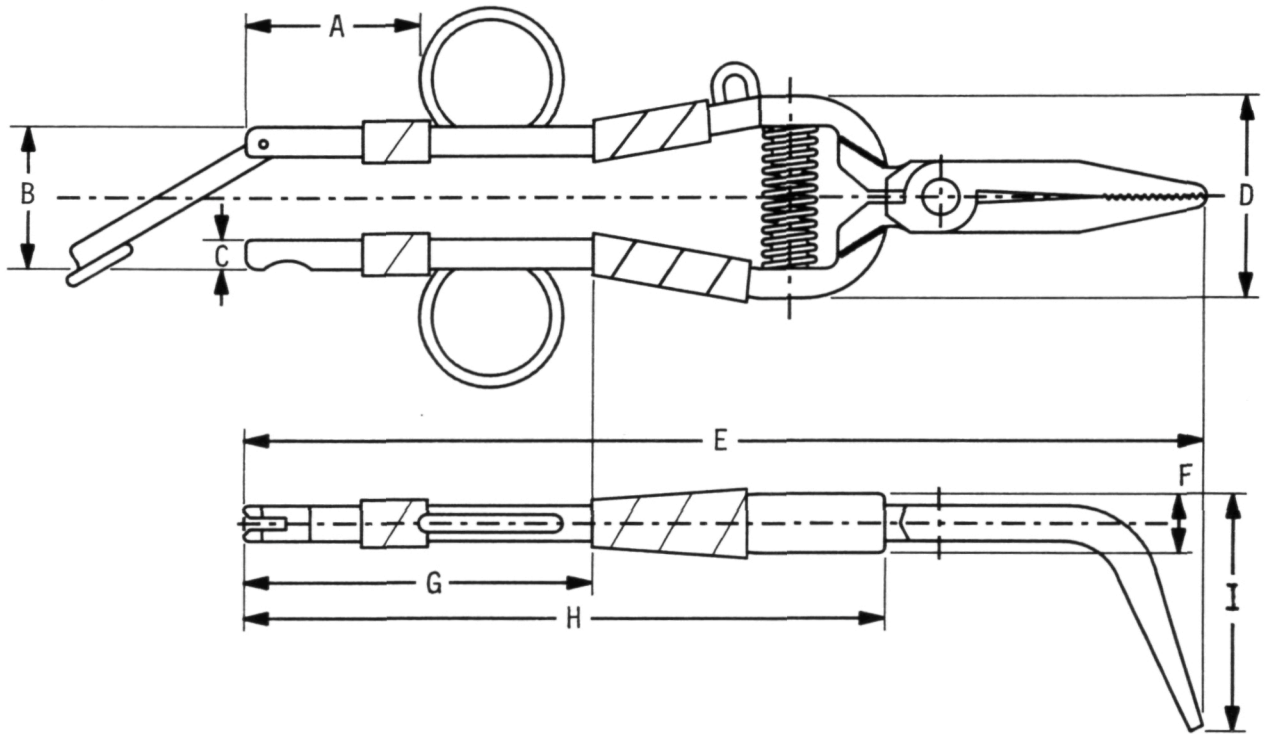
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: J. Madden, Rockwell/Houston, (713) 282-5300

NEEDLE NOSE PLIERS

Technical Information	
Part number	V628-650865-015 or SDD33103438-301
Weight	0.6 lb
Material	AISI 4063 steel, RC 40 to 45
Plating	Commercial electroless nickel plating
Temperature range	-200° to 250° F (operational)
Construction	Handle - Velcro-wrapped, finger rings, one tether ring Jaws - 60° bend, serrated tips
Max. opening	2.0 in.
Quantity flown	One in starboard PSA
Availability	Standard

Dimensional Data	
A	1.125 in.
B	1.500 in.
C	0.250 in.
D	2.000 in.
E	8.900 in.
F	0.500 in.
G	3.000 in.
H	6.000 in.
I	2.680 in.

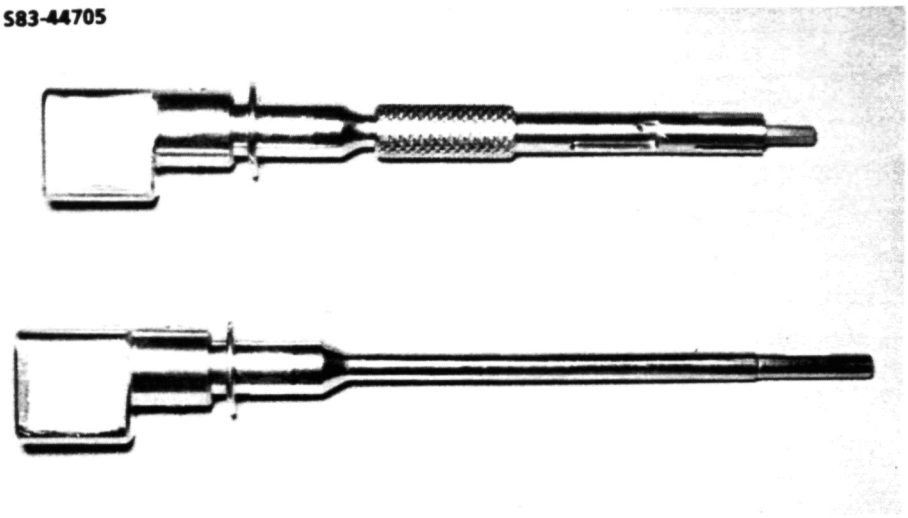


204660099.ART, 2

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

NUMBER 10 ALLEN WRENCH EXTENSION FOR 3/8-INCH DRIVE

S83-44705



OVERVIEW

The number 10 allen wrench extension for 3/8-inch drive, also known as the 5/32-inch allen wrench, has a 5/32-inch allen wrench pinned to one end and a drop-proof tether pinned to the other end. In the -01 configuration, a sliding shroud is spring-loaded to cover the allen wrench and capture the screw being tightened or loosened. The -02 allen wrench extension has a ball-shaped end and no shroud. This design allows 15° off-axis access to the screw.

OPERATIONAL COMMENTS

The number 10 allen wrench extension for 3/8-inch drive was designed for use in disconnecting 5/32-inch cap head screws. A quick-release pin is used to connect the number 10 allen wrench extension to, or disconnect it from, 3/8-inch-drive tools. The allen wrench is usually stored on a tool caddy or on a manipulator foot restraint (MFR) tool board.

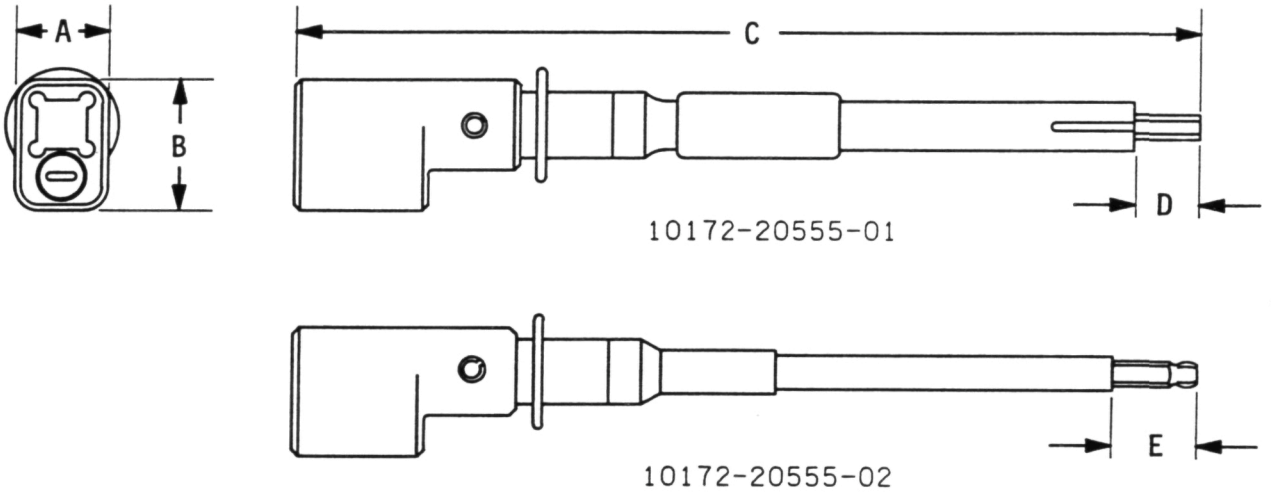
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: T. Ross, NASA/ES6, (713) 483-8941
Source: M. Withey, ILC Space Systems, (713) 488-9080

NUMBER 10 ALLEN WRENCH EXTENSION FOR 3/8-INCH DRIVE

Technical Information	
Part number	10172-20555-01, -02
Weight	0.41 lb
Material	Stainless steel
Stowage	Tool board
Availability	Flight specific

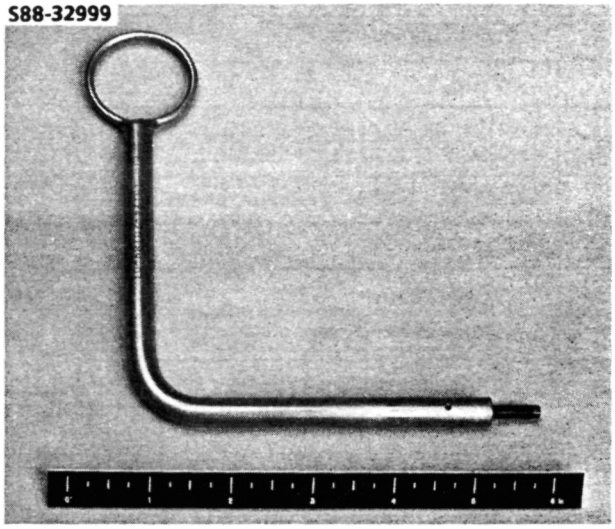
Dimensional Data	
A	0.70 in.
B	1.00 in.
C	6.90 in.
D	0.60 in.
E	0.70 in.



204660100.ART, 2

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

NUMBER 10 ALLEN WRENCH, L-HANDLE



OVERVIEW

The L-handle number 10 allen wrench, also known as the "L" hex allen wrench, was designed for use on the antenna bridge structure (ABS). The wrench consists of a 5-32-inch hex key installed into a stainless steel L-shaped wrench with a tether ring welded to the end opposite the hex key. After assembly of the hex key into the wrench assembly, the wrench is proof tested to 100 in-lb.

OPERATIONAL COMMENTS

The L-handle number 10 allen wrench was designed for contingency use on the ABS, a major piece of hardware used in the satellite retrieval mission STS 51-A. The wrench was included in the manifest as a contingency tool. In the event of problems with the ABS, the wrench was to be used to dismantle the structure. This tool also served as a contingency tool on STS 51-I.

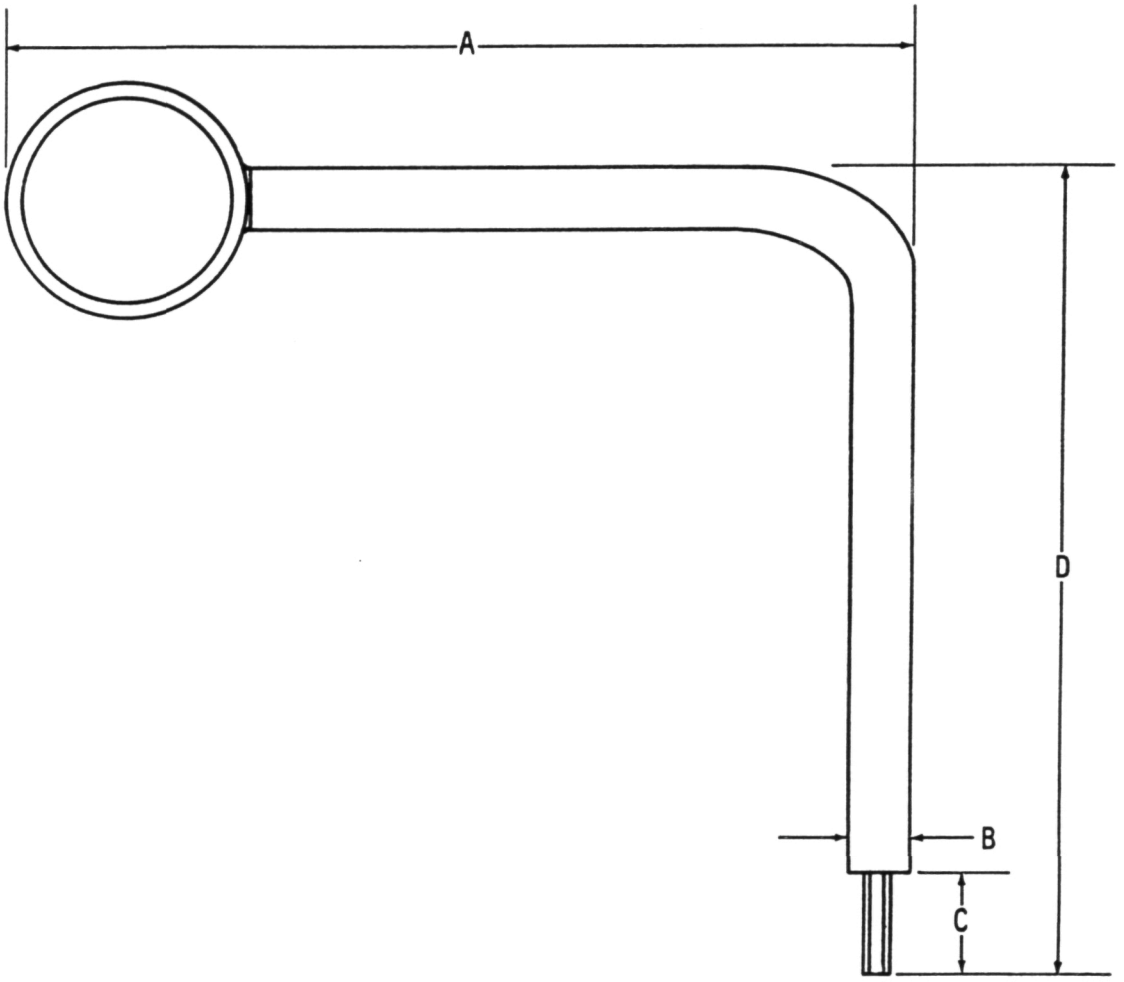
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

NUMBER 10 ALLEN WRENCH, L-HANDLE

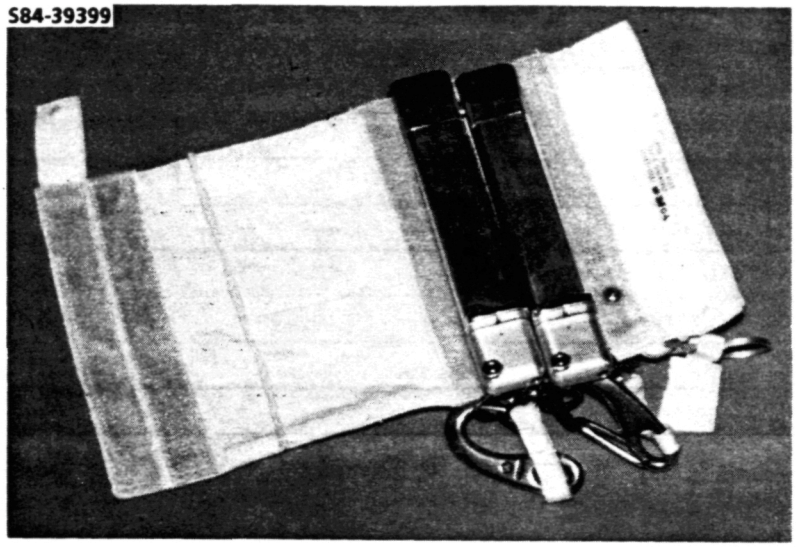
Technical Information	
Part number	10174-20189-01
Weight	0.29 lb
Material/ construction	Hex - high strength steel Handle - stainless steel
Temperature range	-130° to +150° F (operational)
Torque	100 in-lb
Availability	Flight specific

Dimensional Data	
A	5.68 in.
B	0.38 in.
C	0.63 in.
D	5.75 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

PAM-D WEDGE



OVERVIEW

The payload assist module, type D (PAM-D) wedge is an aluminum bar with a flat, rotating tip. The wedge was designed as a contingency tool for use if the PAM-D sunshield fails to open.

OPERATIONAL COMMENTS

If the PAM-D sunshield does not open automatically, an extravehicular (EV) crewmember inserts the wedge into the rotary actuator of the sunshield, thereby closing the switch. The crewmember turns the end of the wedge, causing the tip to turn by means of a shaft inside and lock the wedge in place. When the sunshield indicates open to intravehicular (IV) crewmembers, an EV crewmember can safely cut the cables to allow manual opening of the sunshield.

The PAM-D wedge has a stainless steel tether ring for attachment to a tool caddy or to a wrist or waist tether. Wedges are usually stowed in tool caddies in sets of two.

CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: M. Withey, ILC Space Systems, (713) 488-9080

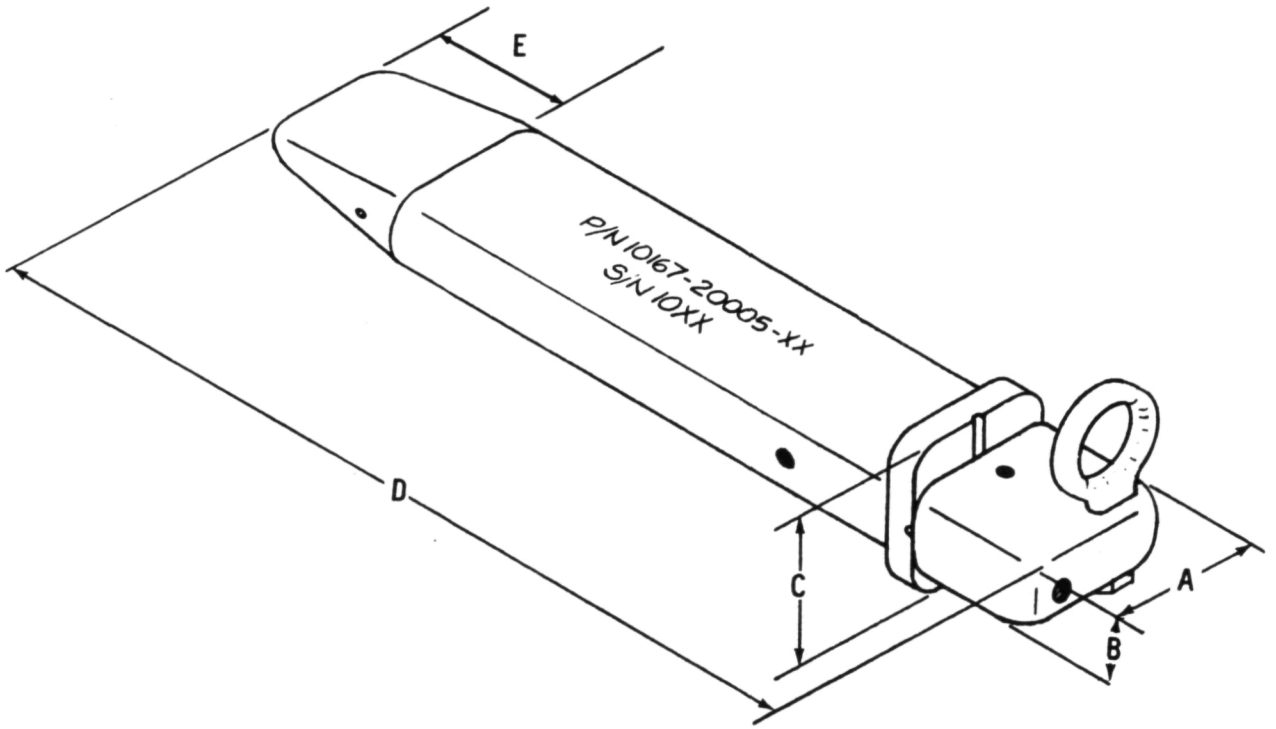
PRECEDING PAGE BLANK NOT FILMED

Section
PAGE 0 INTENTIONALLY BLANK

PAM-D WEDGE

Technical Information	
Part number	10167-20005-03
Weight	0.47 lb (each)
Material	Aluminum alloy
Temperature range	-200° to 250° F (operational)
Quantity flown	Two (one set)
Stowage	Tool caddy in starboard PSA
Availability	Standard

Dimensional Data	
A	1.44 in.
B	0.63 in.
C	1.25 in.
D	7.75 in.
E	1.50 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

PAYLOAD CLAMP ASSEMBLY DRIVER

OVERVIEW

The payload clamp assembly (PCA) driver is an L-shaped handle with a long 1/4-inch hex socket on the end. A rotating tether attachment point allows tethering while the tool is in use. The above photograph is of a training tool mockup.

OPERATIONAL COMMENTS

The PCA driver is used to release or lock the payload clamps manually if the payload clamp actuator mechanism of the instrument pointing system (IPS) fails. Squeezing the tool's mushroom-shaped head releases ball locks, allowing the tool to slide onto the PCA drive hex and lock in place. The PCA drive handle should be used only if the torque limited PCA driver cannot produce sufficient torque. This tool was flown on IPS missions and was stowed in the provisions stowage assembly (PSA). The IPS no longer uses the type of payload clamps which this tool operates.

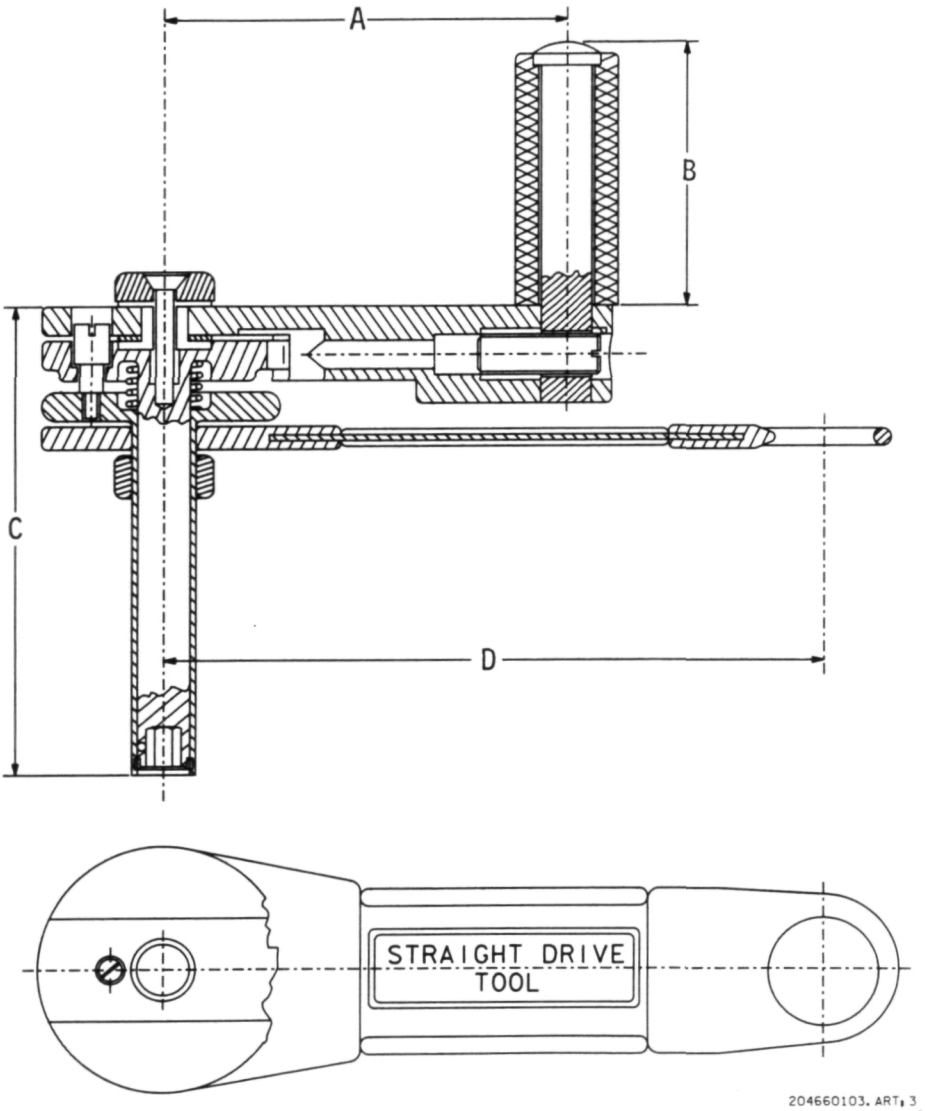
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: M. Naderi, NASA/MSFC, (205) 544-2196
Source: Dornier Systems, Germany

PAYLOAD CLAMP ASSEMBLY DRIVER

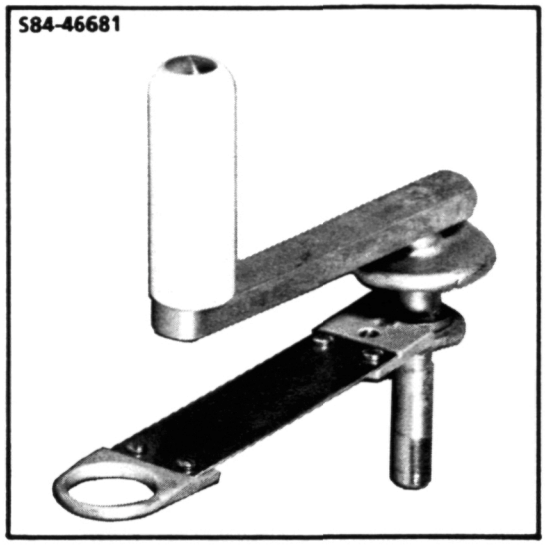
Technical Information	
Part number	883-400330.00.0
Weight	Not available
Material/construction	Aluminum with plastic handle, tool steel drive
Design temperature range	-150° to 250° F
Availability	Flight specific

Dimensional Data	
A	3.94 in.
B	2.95 in.
C	4.01 in.
D	6.42 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

PAYLOAD CLAMP ASSEMBLY TORQUE LIMITED DRIVER



OVERVIEW

The payload clamp assembly (PCA) torque limited driver is an L-shaped handle with a long 1/4-inch hex socket on the end. A torque limiting mechanism is built into the handle, which limits the torque to 1.475 foot-pounds. A rotating tether attachment point allows tethering while the tool is in use. The above photograph is of a training tool mockup.

OPERATIONAL COMMENTS

The PCA torque limited driver is used to release or lock the payload clamps manually if the payload clamp actuator mechanism of the instrument pointing system (IPS) fails. Squeezing the tool's mushroom-shaped head releases ball locks, allowing the tool to slide onto the PCA drive hex, and lock in place. This tool was flown on IPS missions and was stowed in the provisions stowage assembly (PSA). The IPS no longer uses the type of payload clamps which this tool operates.

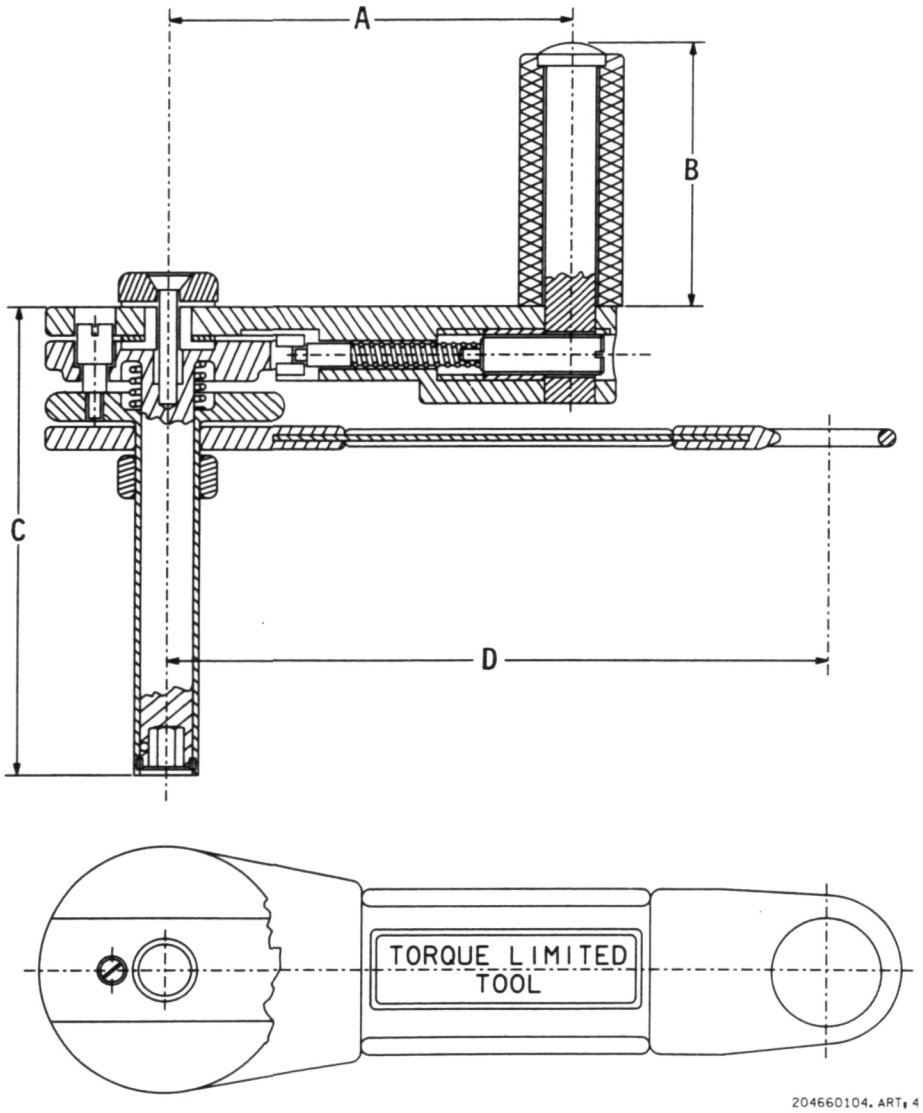
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: M. Naderi, NASA/MSFC, (205) 544-2196
Source: Dornier Systems, Germany

PAYLOAD CLAMP ASSEMBLY TORQUE LIMITED DRIVER

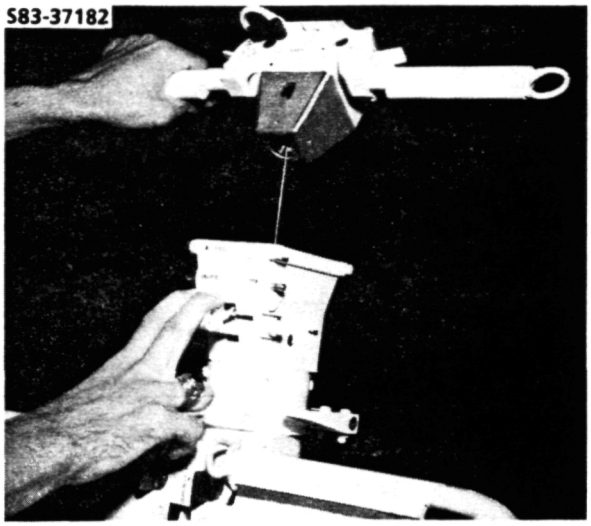
Technical Information	
Part number	883-400320.00.0
Weight	Not available
Material/construction	Aluminum frame, plastic rotating handle, tool steel drive
Design temperature range	-150° to 250° F
Availability	Flight specific

Dimensional Data	
A	3.94 in.
B	2.95 in.
C	4.01 in.
D	6.42 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

PAYLOAD INTERFACE MECHANISM



OVERVIEW

The payload interface mechanism (PIM) mounts on top of the manipulator foot restraint (MFR) stanchion. It is a tethering device for attaching a payload to the MFR and consists of three main parts: a payload fitting, a pyramid fitting, and a pyramid housing. The pyramid fitting and the pyramid housing are connected by a retractable tether. Tether attachment rings are provided on the ends of the pyramid fitting handles and on the payload fitting.

OPERATIONAL COMMENTS

The PIM was designed for temporary stowage and transfer of the module servicing tool (MST). The pyramid fitting attaches to the payload fitting mounted on the MST. Then the pyramid fitting and the MST are pulled over to the MFR and latched onto the pyramid housing. The MST is released from the PIM by turning the lock-unlock lever on the pyramid fitting and depressing the release levers on the payload fitting handles. The pyramid fitting is released from the pyramid housing by pushing the lock-unlock bar on the pyramid housing to the unlock position and depressing the housing latch handle.

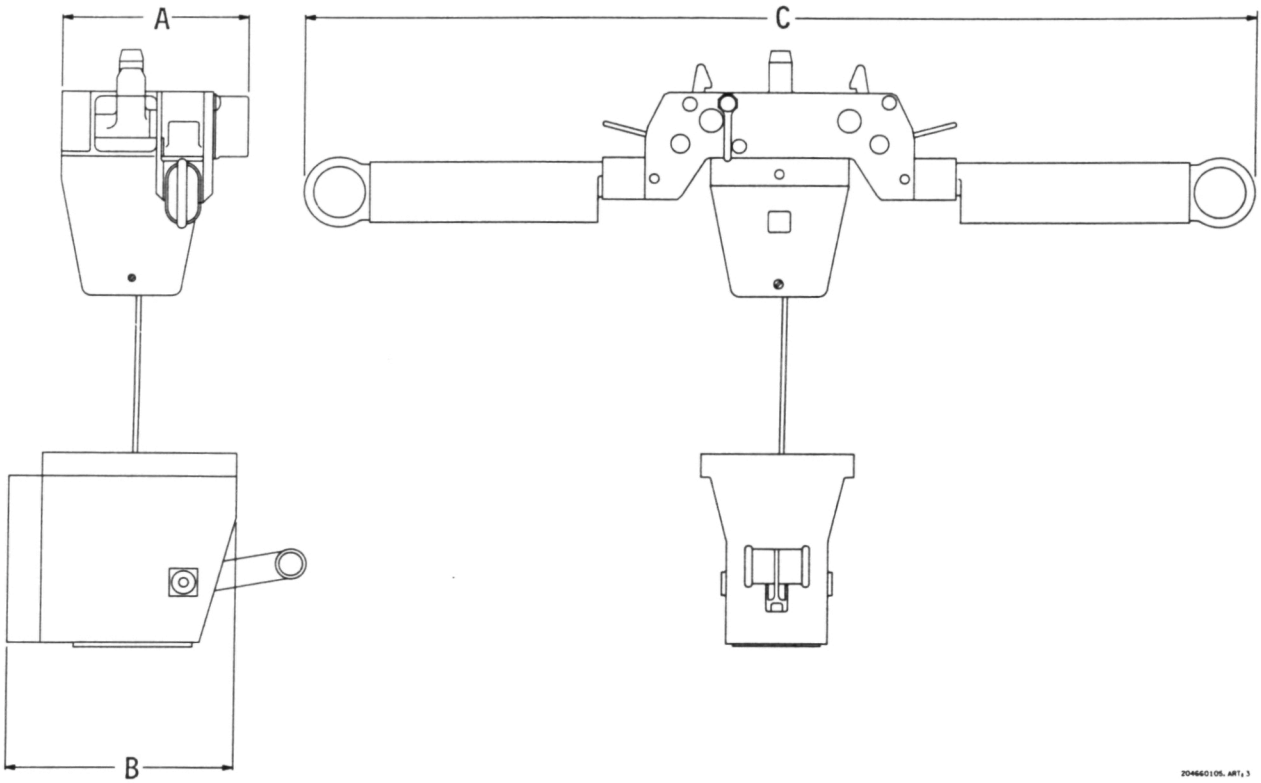
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: T. Ross, NASA/ES6, (713) 483-8941
Source: S. Abraham, Grumman Aerospace Corp., (516) 575-9553

PAYLOAD INTERFACE MECHANISM

Technical Information	
Part number	C95-105
Weight	5.5 lb
Material	Aluminum
Tether length	6 ft
Quantity flown	One with the MFR
Availability	Flight specific

Dimensional Data	
A	4.060 in.
B	5.560 in.
C	20.875 in.

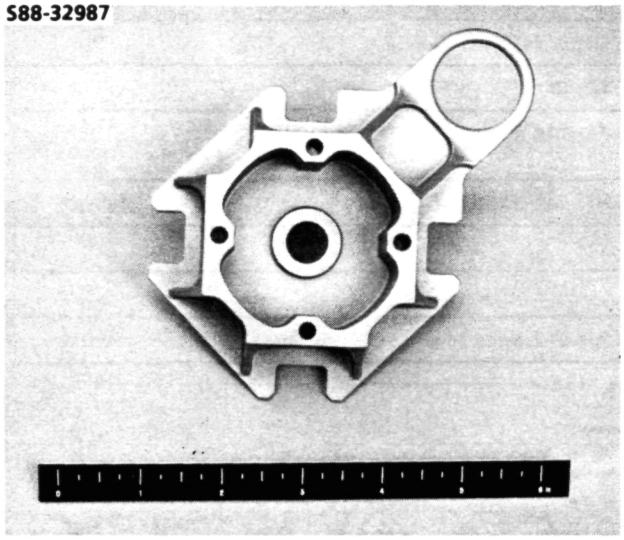


204660105.ART,3

C-4

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

PAYLOAD INTERFACE MECHANISM ADAPTER



OVERVIEW

The payload interface mechanism (PIM) adapter is the passive half of a latching system that is used to secure items to the manipulator foot restraint (MFR). The active half of the latching system is a part of the MFR. The PIM adapter incorporates four rotational orientations of latching positions, and two diagonally opposite points are used at a time. This item can be attached to any instrument by using four number 10 flathead mounting screws.

OPERATIONAL COMMENTS

The PIM adapter is used by aligning the MFR PIM with the adapter and then pushing the two halves towards each other. This will latch the two locking pawls of the PIM to the adapter. The connection provided results in a stable, positive tethering system.

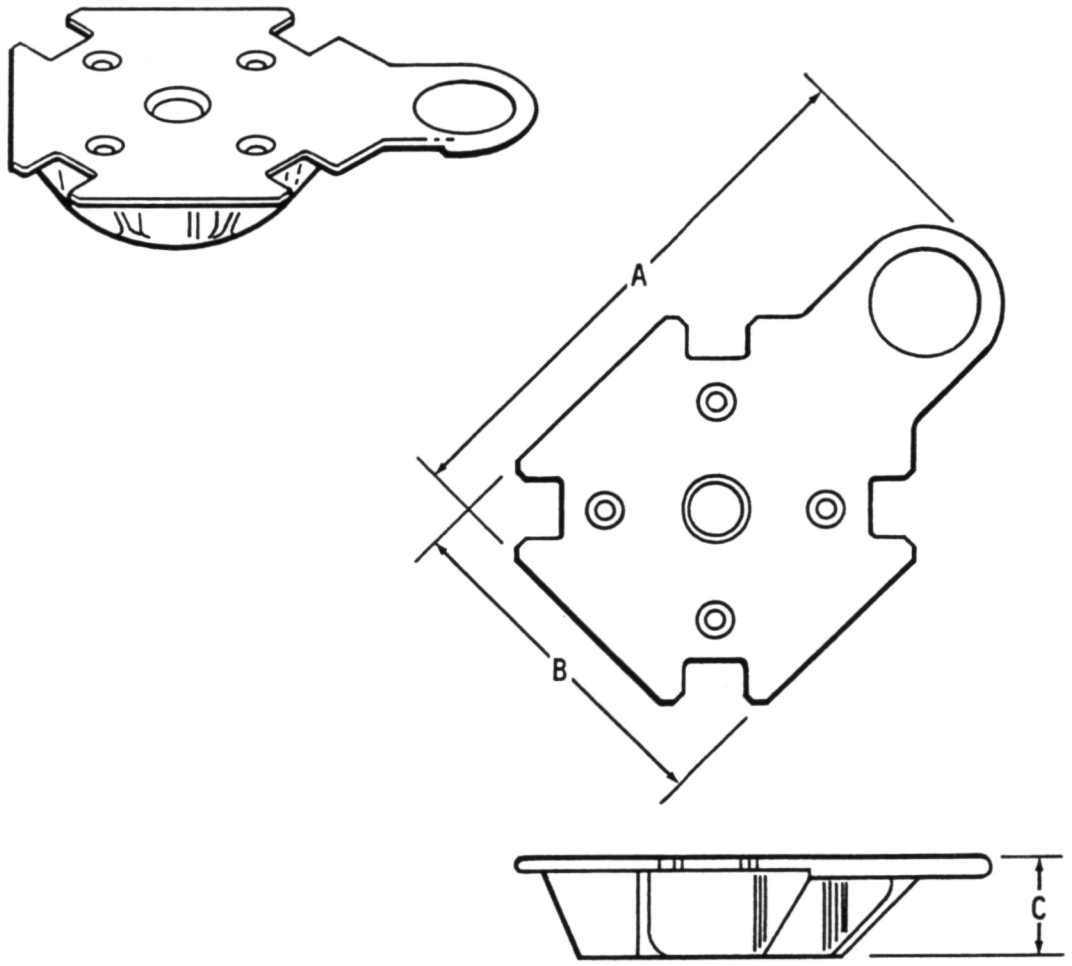
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

PAYLOAD INTERFACE MECHANISM ADAPTER

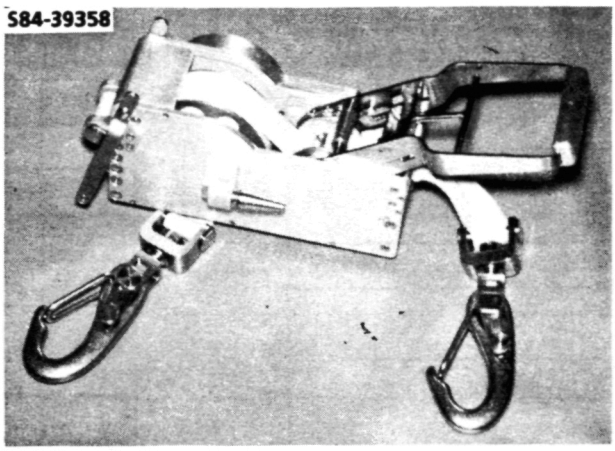
Technical Information	
Part number	10181-10049-01
Weight	0.32 lb
Material/ construction	Aluminum
Temperature range	-150° to +250° F (operational)
Availability	Flight specific

Dimensional Data	
A	5.55 in.
B	3.60 in.
C	1.00 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

PAYLOAD RETENTION DEVICE



OVERVIEW

The payload retention device (PRD) is used as a contingency restraint or come-along device for on-orbit use. It consists of a Kevlar webbing strap with french hooks on the ends and a stainless steel and aluminum ratchet mechanism for tightening. The PRD also has a universal interface adapter for attachment to a mini work station.

OPERATIONAL COMMENTS

The PRD can be attached with french hooks to tether points in the cargo bay or on the equipment to be secured or to another PRD. After both ends of the PRD are hooked in place, the crewmember pulls the handle to operate the ratchet, tightening the strap until the equipment is secure. The ratchet mechanism reels in the strap slowly enough so that the article being secured can be repositioned as necessary to prevent damage. The PRD does not allow controlled release of tension.

The PRD can be attached to waist or wrist tethers or to the mini work station for transport during EVA. Two PRD's are nominally stowed in the port provisions stowage assembly (PSA) for launch and entry.

The preload capability of the PRD limits its tiedown capability to objects on the order of 500 pounds or less. The PRD is certified only for on-orbit restraint applications. Webbing tension tends to relax with vibration loading. The strap must be wrapped 2.5 times around the takeup reel for tension assurance.

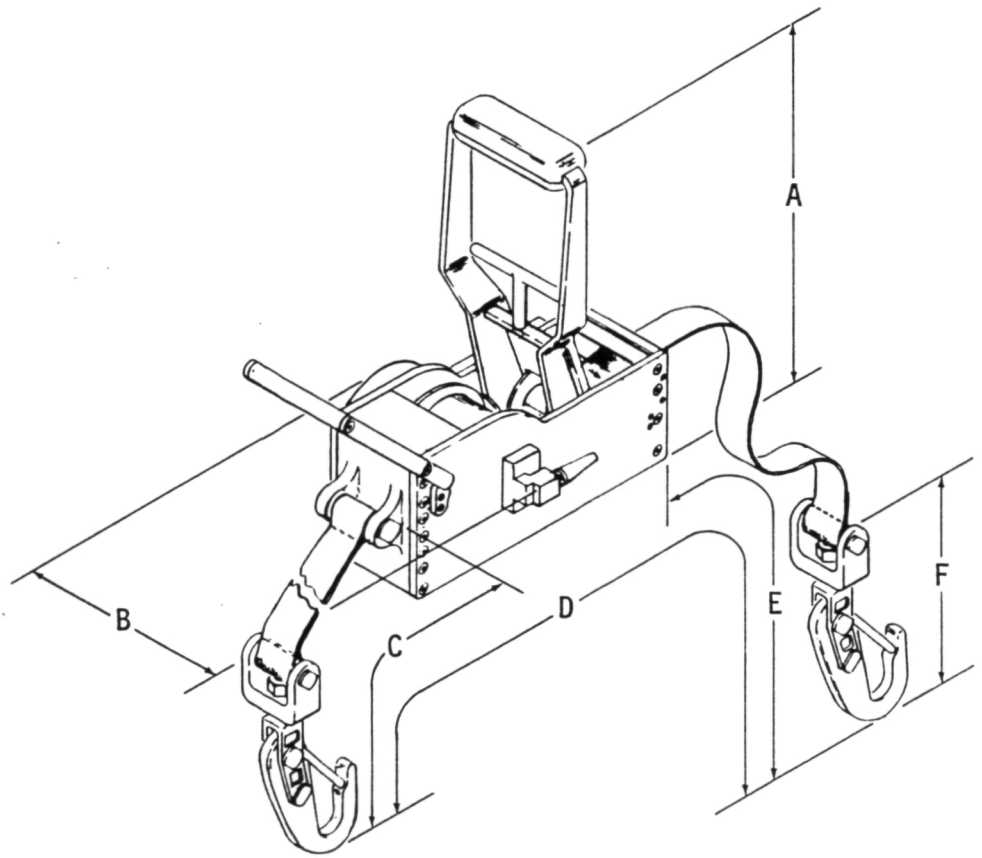
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: M. Withey, ILC Space Systems, (713) 488-9080

PAYLOAD RETENTION DEVICE

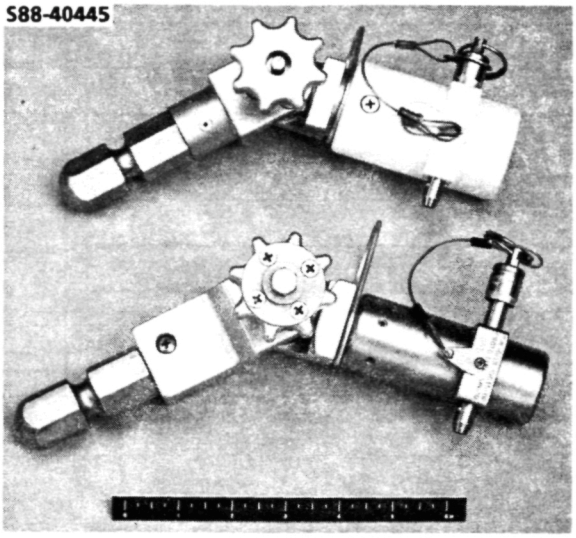
Technical Information	
Part number	10163-10063-03 (10163-20057-01 hooks)
Weight	8.0 lb
Material	Aluminum, stainless steel, Kevlar (strap), Teflon (bearings)
Temperature range	-200° to 250° F (operational)
Maximum operating tensile load	2000 lb
Nominal crew inducable strap tension	350 lb
Quantity flown	Two
Stowage	Port PSA
Availability	Standard

Dimensional Data	
A	9.75 in.
B	4.63 in.
C	11.33 in.
D	15.83 ft
E	13.98 ft
F	6.00 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

PFR ARTICULATING SOCKET



OVERVIEW

The portable foot restraint (PFR) articulating socket has a 12-point socket on one end connected by a gimbal joint to a hex insert at the other end. There is a tethering point between the gimbal joint and socket. The -01 configuration is shown at the top of the photo above. The depicted article does not have the flight configuration locking knob. The -02 configuration shown below has the correct locking knob.

OPERATIONAL COMMENTS

The PFR articulating socket interfaces with the PFR socket at the hex insert end and with the PFR extension arm at the socket end. By manipulating the knob on the articulating socket, the crewmember can set the PFR at the position desired for EVA. The hex end of the articulating socket can be placed in a PFR socket in any of 12 positions 30° apart and may be directed in 15° increments in a ±2° range. A tethered quick-disconnect pin locks the PFR extension arm into the articulating socket.

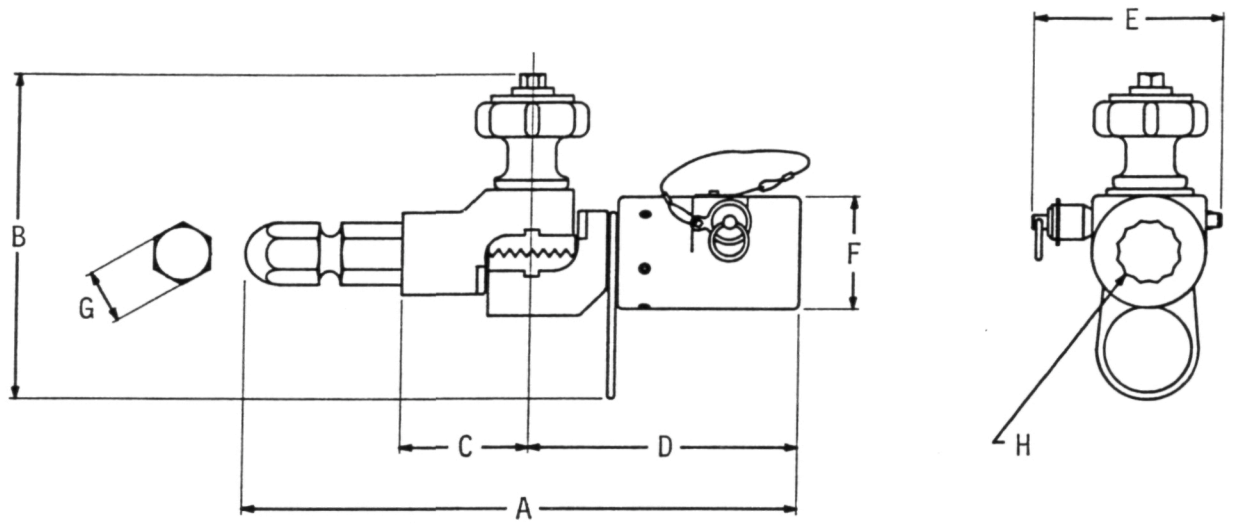
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: W. D. Harwell, NASA/EC5, (713) 483-9155
Source: M. Withey, ILC Space Systems, (713) 488-9080

PFR ARTICULATING SOCKET

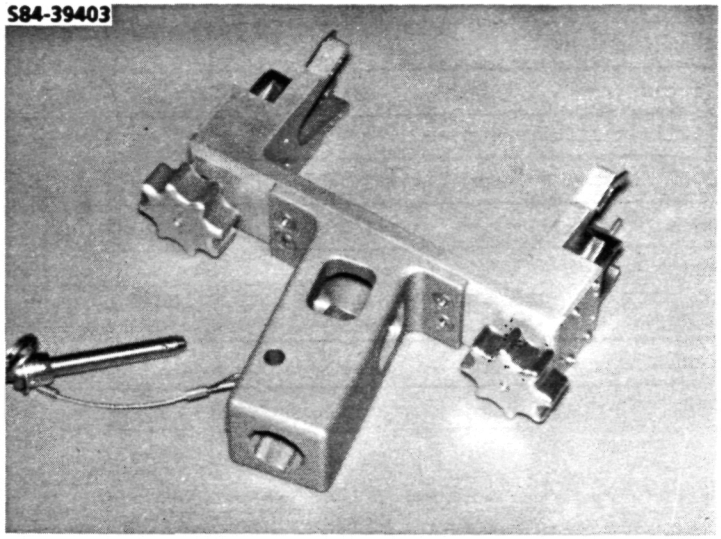
Technical Information	
Part number	10159-10035-01/02
Weight	1.72 lb (-02)
Material	Stainless steel
Stowage	Payload bay
Availability	(-01) flight specific (-02) developmental

Dimensional Data	
A	11.2200 in.
B	6.8800 in.
C	2.7500 in.
D	5.2200 in.
E	3.7500 in.
F	2.0000 in. (-01) 1.5000 in. (-02)
G	0.9990 in.
H	1.0045 in. across flats



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

PFR CENTERLINE CLAMP ASSEMBLY



OVERVIEW

The portable foot restraint (PFR) centerline clamp assembly is used to attach the PFR platform assembly to the centerline latches of the payload bay doors. After installation, the PFR/centerline clamp system provides contingency restraint for a crewmember using the centerline latch bypass tool during closure or repair of the payload bay centerline door latches. The clamp consists of two tightening knobs, capture jaws, and alignment tabs. It has a yaw adjustment capability of 360° in 30° increments. The inside diameter of the clamp is 5.08 centimeters.

OPERATIONAL COMMENTS

The PFR centerline clamp attaches to the centerline latch passive roller guides and allows access to the centerline latches. The clamp jaws will snap onto the latch rollers during installation. The tightening knobs are then used to complete the installation, securing the clamp to the centerline latch. One clamp assembly is currently flown in the port provisions stowage assembly (PSA) on all missions.

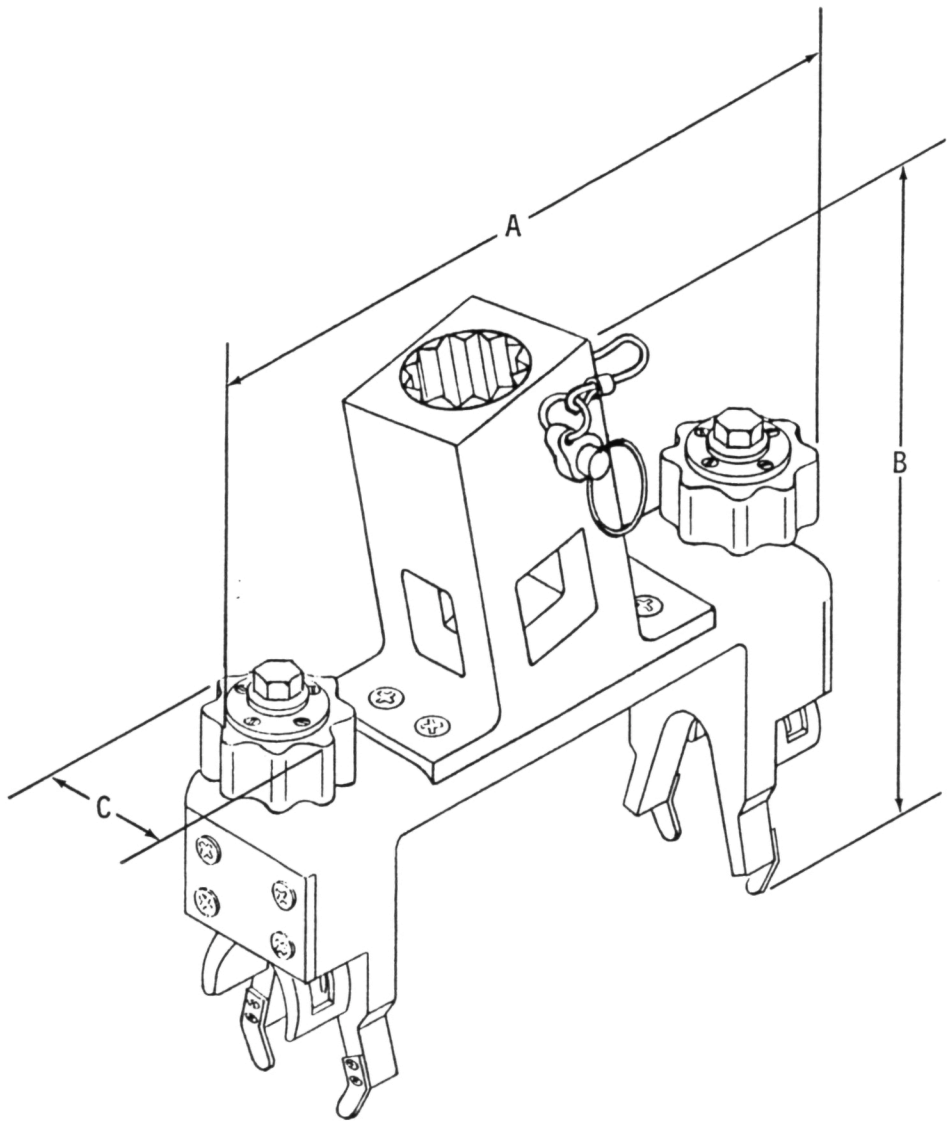
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: M. Withey, ILC Space Systems, (713) 488-9080

PFR CENTERLINE CLAMP ASSEMBLY

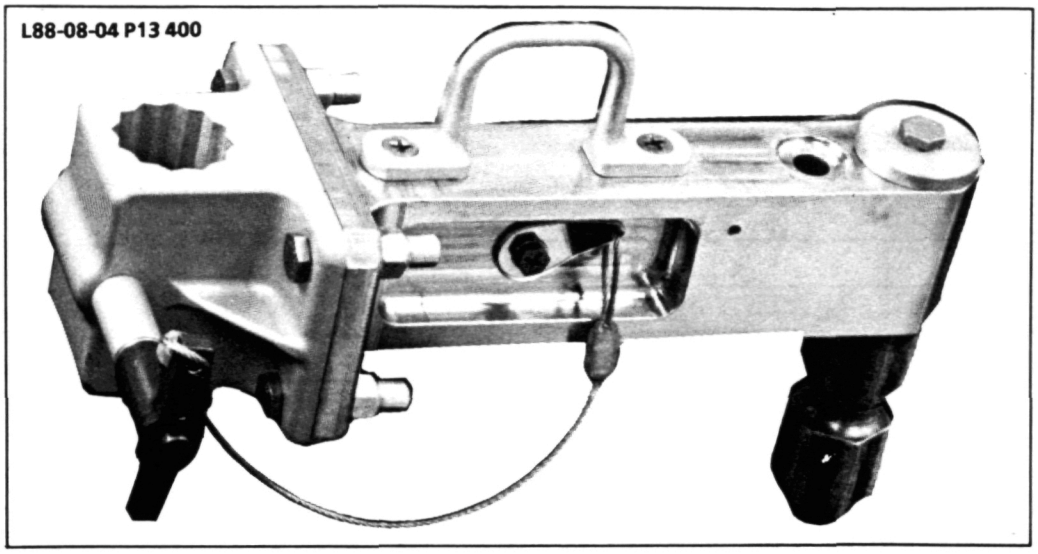
Technical Information	
Part number	10155-20004-04
Weight	3.5 lb
Material	Stainless steel, aluminum
Temperature range	-200° to 250° F (operational)
Quantity flown	One
Stowage	Port PSA
Availability	Standard

Dimensional Data	
A	9.12 in.
B	8.70 in.
C	2.00 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

PFR EXTENDER



OVERVIEW

The Hubble Space Telescope (HST) portable foot restraint (PFR) extender has a 12-point socket on one end and a hex insert on the other. There is a tether loop on the extender and a pip pin for securing the extender in the PFR socket. The PFR extender was originally designed to use on HST PFR foot restraint receptacles 10 and 18 to avoid contact with the magnetic torquer assembly. However, this extender is applicable for all PFR sockets.

OPERATIONAL COMMENTS

The PFR extender interfaces with the PFR socket at the hex insert end and the PFR hex pin at the socket end. The PFR extender hex end can be placed in a PFR socket in any position; however, some positions are limited for a few PFR sockets. A tethered pip pin locks the PFR hex pin into the 12-point socket.

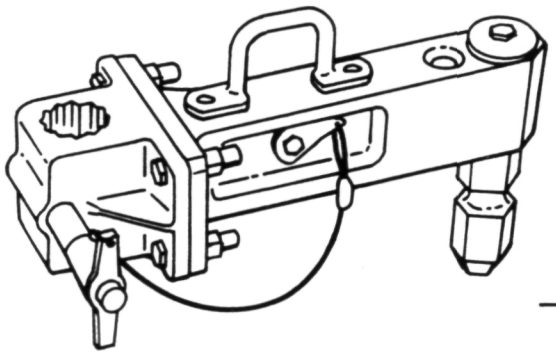
CONTACTS

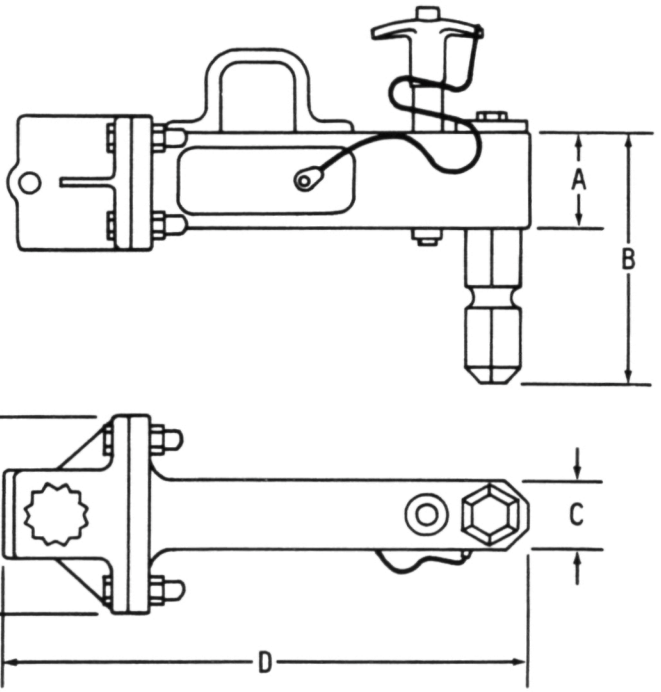
Operational: S. P. Boyd, NASA/DF42, (713) 483-1755
Technical: R. L. Sheffield, LMSC/Dept. G4-10, (408) 742-8464
Source: LMSC, HST Contracts Office, (408) 742-5505

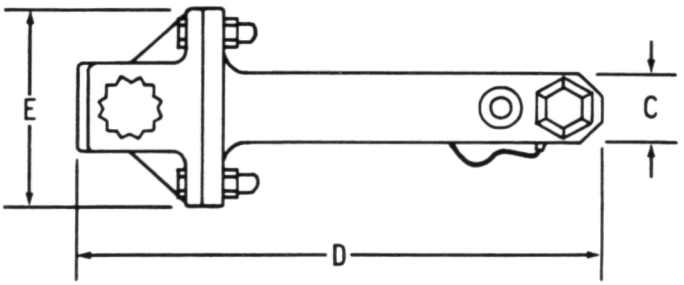
PFR EXTENDER

Technical Information	
Part number	4177502
Weight	3.0 lb
Material	Aluminum/stainless steel
Temperature range	-250° to +250° F
Availability	Flight specific

Dimensional Data	
A	2.000 in.
B	5.375 in.
C	2.000 in.
D	9.390 in.
E	3.620 in.

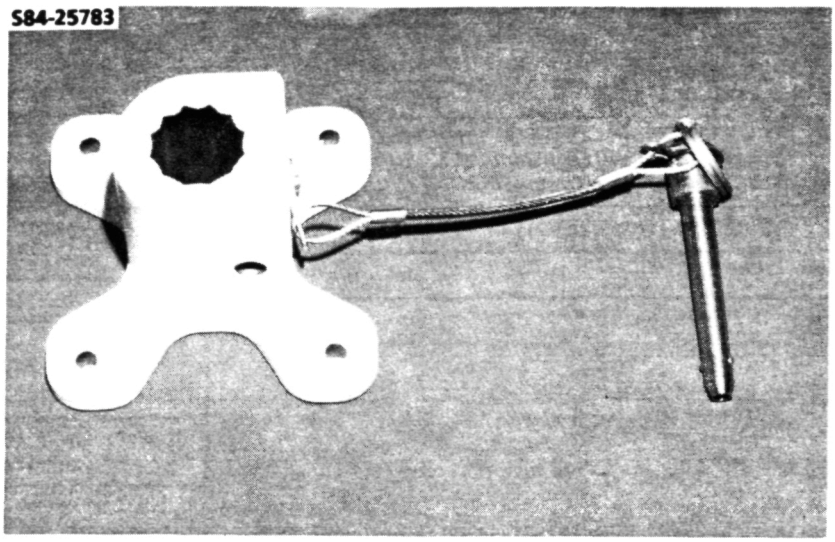






ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

PFR SOCKET



OVERVIEW

The portable foot restraint (PFR) socket, also called the 12-point socket, secures the PFR extension arm to a stationary location. There are three types of PFR sockets. Two types have only one socket position; the third has separate socket positions for stowage and use. Each type has a 12-point polygon-shaped receptacle into which the hex-shaped probe of a PFR is inserted and secured by a tethered pip pin.

OPERATIONAL COMMENTS

The PFR socket used on the Solar Maximum Satellite (Solar Max) Repair Mission (10172-20433-01) is made of stainless steel and has one PFR receptacle. The PFR socket 10174-20019-01 is made of aluminum and has two PFR receptacles in which the PFR extension arm may be secured: one for launch, the other for use. The PFR socket 10176-20648-01 is similar to the Solar Max socket except that it is made of aluminum and has a thicker base to withstand greater loads. The PFR can be mounted to the socket for launch and EVA use. A tethered pip pin is incorporated to lock the socket to the PFR.

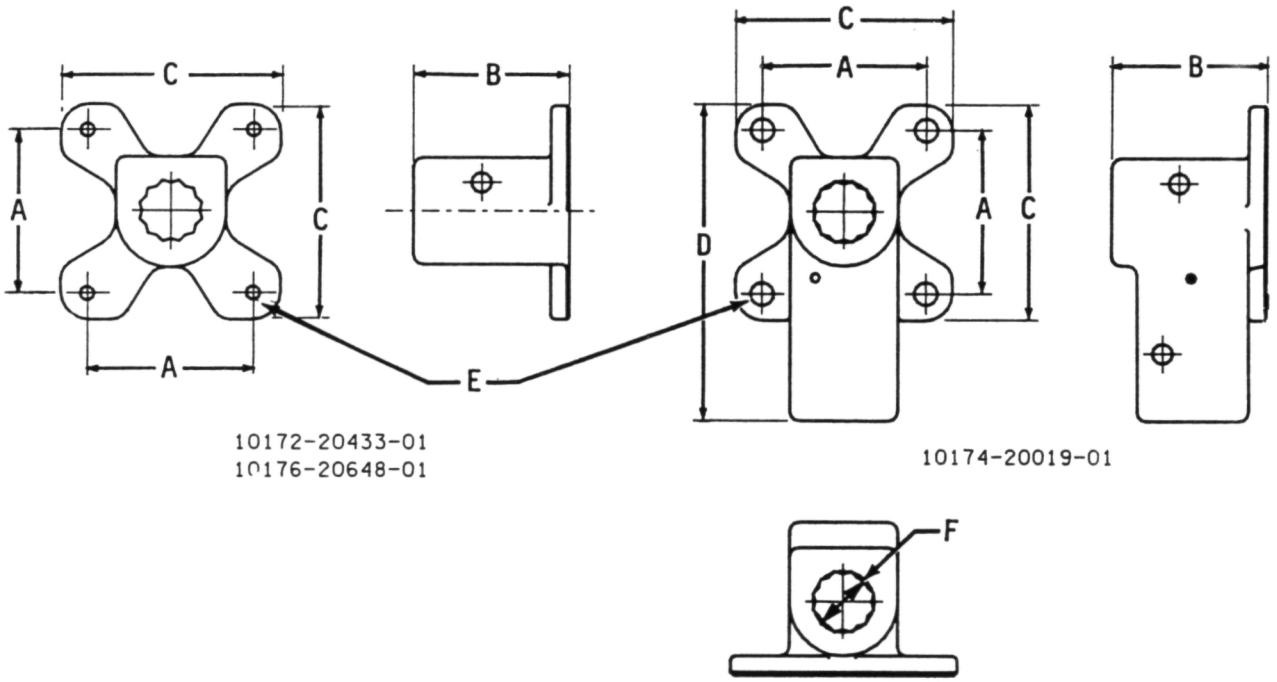
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

PFR SOCKET

Technical Information	
Part number	10172-20433-01 10174-20019-01 10176-20648-01
Material/weight	10172-20433 - stainless steel/6.0 lb 10174-20019 - aluminum/2.813 lb 10176-20648 - aluminum/2.0 lb
Design load	100 lb (any direction)
Availability	Flight specific

Dimensional Data	
A	3.000 in.
B	2.880 in.
C	4.000 in.
D	5.880 in.
E	10172-20433 0.281 dia
	10174-20019 0.406 dia
	10176-20648 0.404 dia
F	1.0045 in. across flats



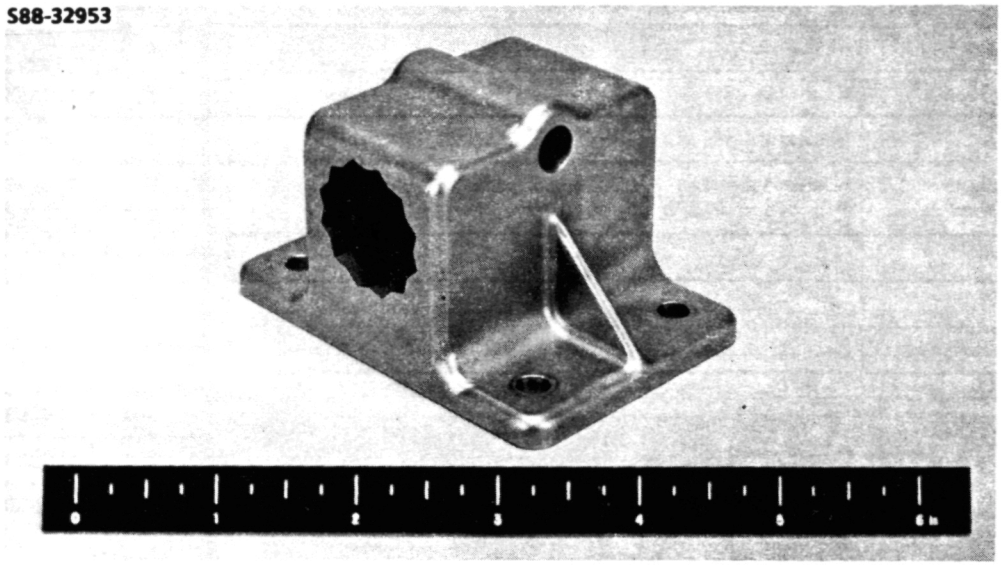
204660109. ART. 2

PFR SOCKET

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

PFR SOCKET (HST)

S88-32953



OVERVIEW

The Hubble Space Telescope (HST) portable foot restraint (PFR) socket is a dual ended 12-point socket which mates with the HST PFR hex probe. It provides a stable foot restraint for an EVA crewmember performing HST maintenance or repair. The PFR socket receptacles are located at various work stations along the shell of the HST.

OPERATIONAL COMMENTS

The PFR socket is equipped with a pip pin hole. When the HST PFR is inserted into the socket, a pip pin attached to the PFR is inserted to prevent the PFR from coming out of the socket. The PFR socket structure has four mounting holes 0.287 inch in diameter for mounting. Because of the large number of PFR sockets on the HST, each socket does not have an attached pip pin but relies on a pip pin from the PFR. This item is also known as the foot restraint receptable (FRR) in HST terminology.

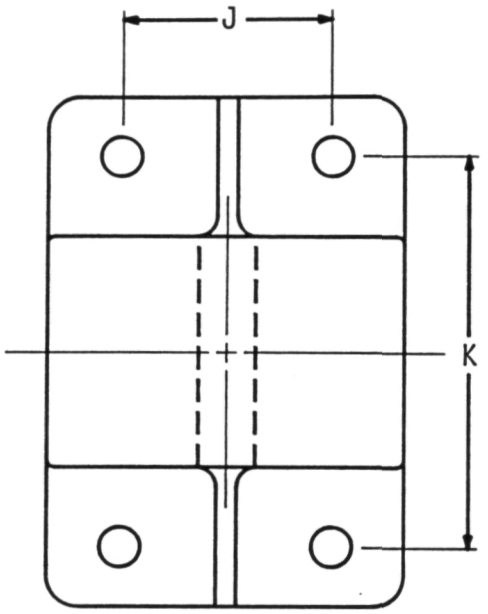
CONTACTS

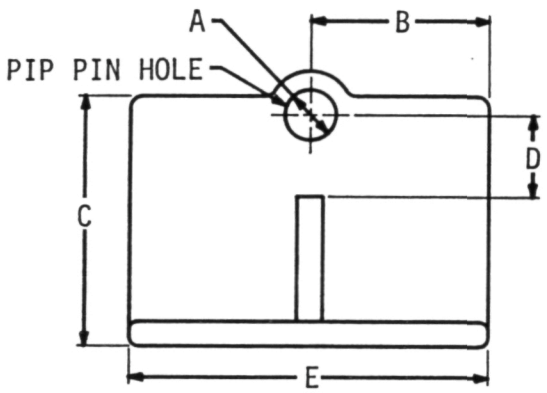
Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. Sheffield, LMSC/DEPT 64-10, (408) 742-8464
Source: LMSC, HST Contracts Office, (408) 742-5505

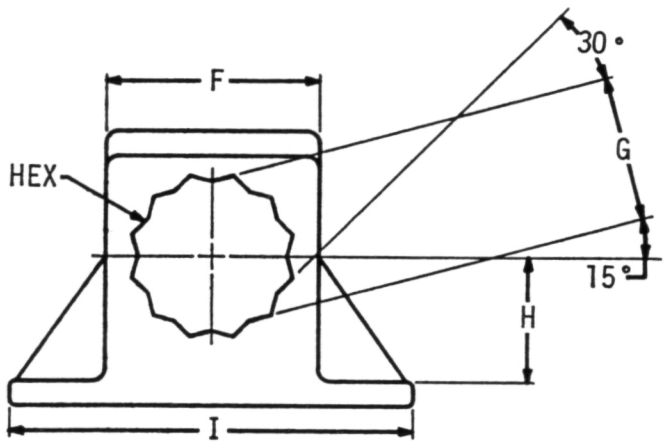
PFR SOCKET (HST)

Technical Information	
Part number	4173704
Weight	0.78 lb
Material	Aluminum alloy
Construction	Mounting holes - 0.287-in. dia Pip pin - 0.375 in. dia
Availability	Flight specific

Dimensional Data	
A	0.3750 in.
B	1.2500 in.
C	2.0000 in.
D	0.5440 in.
E	2.5000 in.
F	1.6250 in.
G	1.0055 in.
H	1.2500 in.
I	3.6200 in.
J	1.6250 in.
K	2.7500 in.





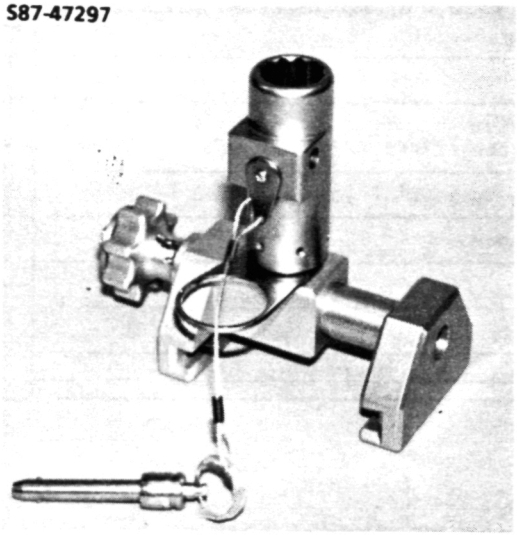


204660110.ART, 4

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

PFR SOCKET, BRIDGE FITTING

S87-47297



OVERVIEW

The bridge fitting portable foot restraint (PFR) socket, also known as the PFR bridge attachment clamp, provides the capability to mount a PFR along the sill longeron to certain longeron bridges. It consists of a screw-driven clamp with a locking knob and a 12-point receptacle into which the hex-shaped probe of a PFR or articulating socket is inserted and secured by use of a tethered pip pin.

The bridge fitting PFR socket is designed to mount to the longeron bridges used to secure the payload retention latch assemblies (PRLA's) to the sill longeron. Space is usually available on the top of the longeron bridge to mount the clamp forward or aft of the PRLA. The bridge fitting PFR socket allows the PFR to be mounted in the vicinity of the payload.

OPERATIONAL COMMENTS

The bridge fitting PFR socket is clamped to the longeron bridge fitting by turning a conveniently located fluted knob. The knob has a locking feature which ensures that the clamp will not loosen once the desired clamping force has been attained.

A permanently tethered pip pin holds the PFR in place at the desired orientation. This device can withstand a load of 100 pounds applied 72 inches above the base of the 12-point socket. A 1.5-inch inside diameter tether ring is part of the socket assembly.

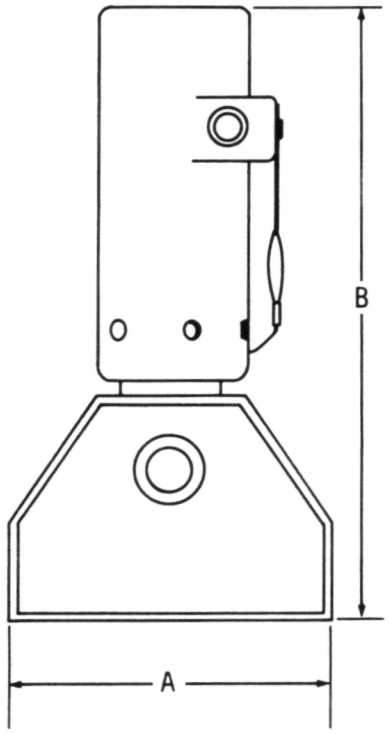
CONTACTS

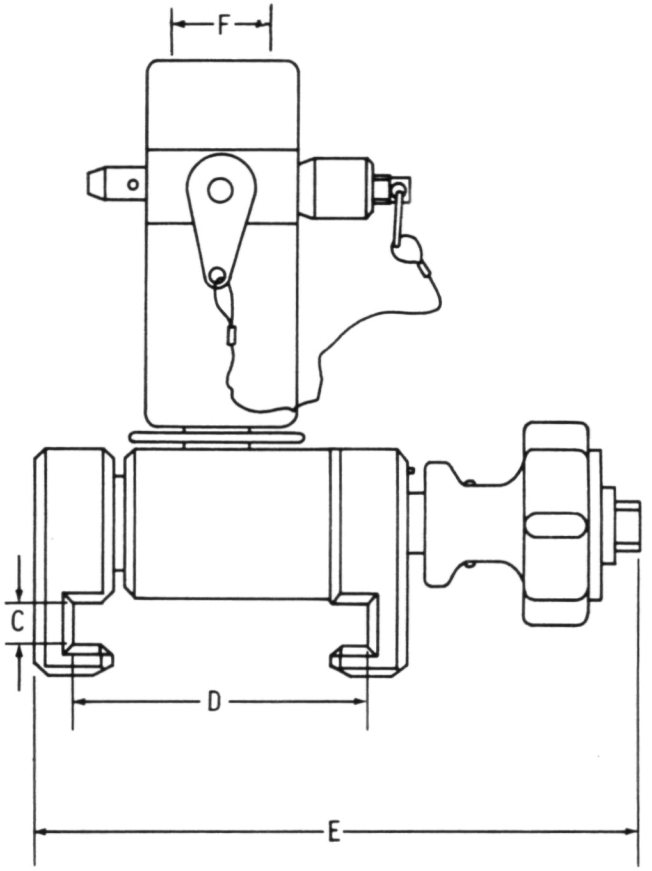
Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

PFR SOCKET, BRIDGE FITTING

Technical Information	
Part number	10159-10037-01
Weight	3.058 lb
Material/ construction	Aluminum Stainless steel
Temperature range	-130° to +150° F (operational)
Lubrication	Molykote
Availability	Developmental

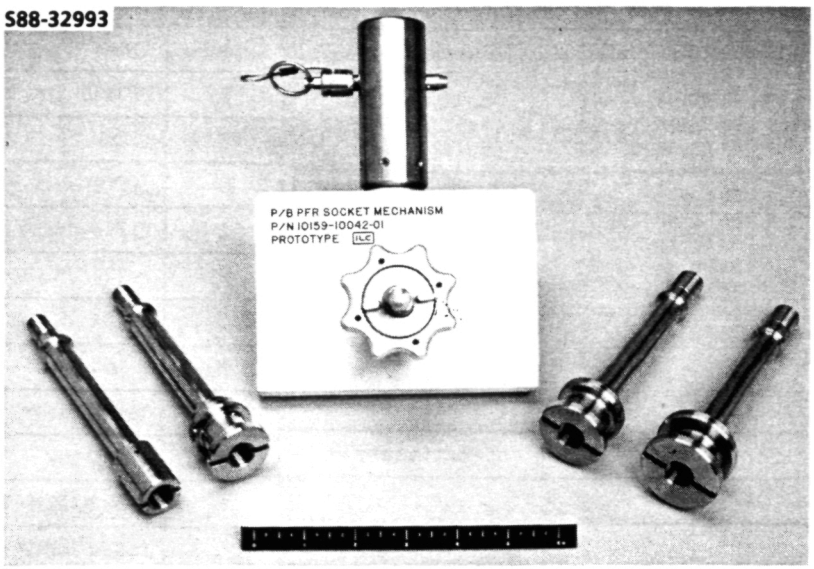
Dimensional Data	
A	3.2500 in.
B	6.1250 in.
C	0.4700 in.
D	2.9400 in. closed 3.4400 in. open
E	5.8700 in. closed 7.3700 in. open
F	1.0045 in. across flats





ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

PFR SOCKET, SILL LONGERON



OVERVIEW

The sill longeron portable foot restraint (PFR) socket, also known as the payload bay PFR socket mechanism, allows the existing PFR to be mounted at numerous points in the cargo bay.

OPERATIONAL COMMENTS

The sill longeron PFR socket is designed to be mounted on the sill longeron with one of four special bolts which are supplied with the socket. The special bolts are installed into existing holes in the longeron and the socket is clamped to the bolt by turning a conveniently located fluted knob. The knob has a locking feature which ensures that the clamp will not loosen once the desired clamping force has been attained.

A permanently tethered pip pin holds the PFR in place at the desired orientation. This structure can withstand a load of 100 pounds applied 72 inches above the base of the 12-point socket. A 1.5-inch inside diameter tether ring is part of the socket assembly.

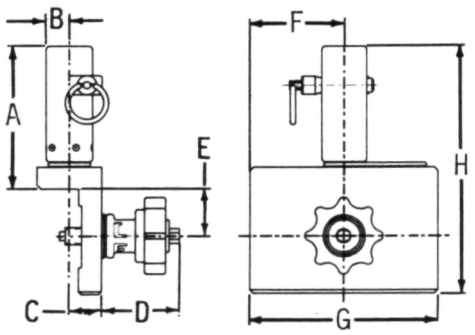
CONTACTS

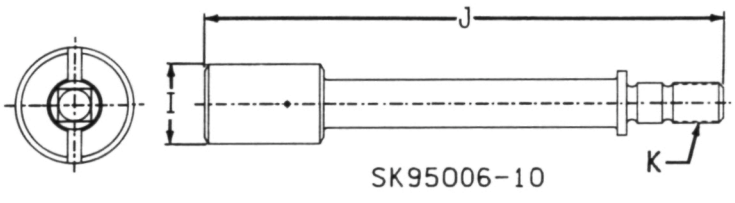
Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

PFR SOCKET, SILL LONGERON

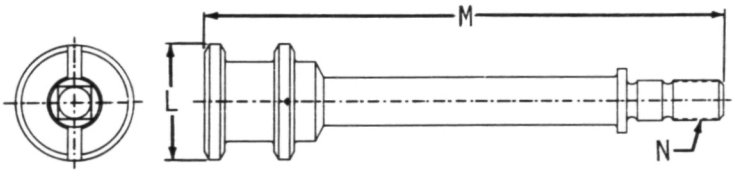
Technical Information	
Part number	10159-10042-01 (socket) SK95006-10-01 (bolt no. 1) SK95006-12-01 (bolt no. 2) SK95006-12-02 (bolt no. 3) SK95006-12-03 (bolt no. 4)
Weight	Socket 4.258 lb Bolt no. 1 0.564 lb Bolt no. 2 0.706 lb Bolt no. 3 0.780 lb Bolt no. 4 0.856 lb
Material/ construction	Socket - Aluminum Stainless steel Aluminum bronze Bolts - Stainless steel
Temperature range	-130° to +150° F (operational)
Availability	Developmental

Dimensional Data	
A	4.625 in.
B	1.0045 in. Across flats
C	0.250 in.
D	3.870 in.
E	1.750 in.
F	3.000 in.
G	6.000 in.
H	8.250 in.
I	0.935 in.
J	6.290 in.
K	0.5-20UNJF-3A
L	1.372 in. (-01) 1.497 in. (-02) 1.716 in. (-03)
M	6.290 in. (-01) 6.370 in. (-02/03)
N	0.5-20UNJF-3A (-01) 0.62-18UNJF-3A (-02/03)

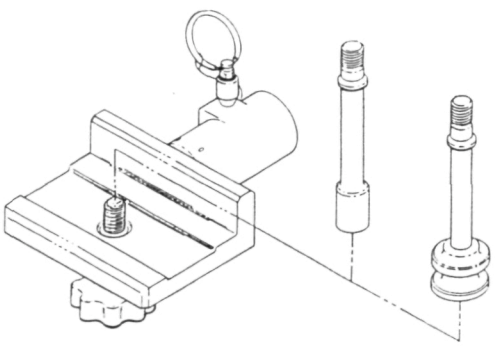




SK95006-10



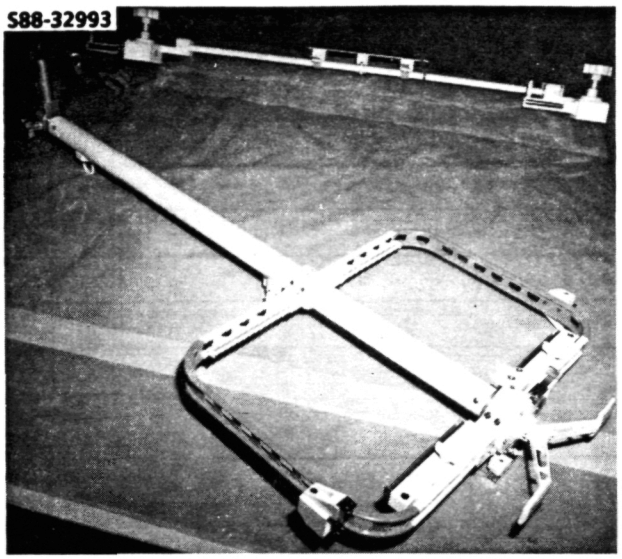
SK95006-12



204660180.ART;3

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

PFR WORK STATION STANCHION



OVERVIEW

The portable foot restraint (PFR) work station stanchion is a support structure that attaches to a modified PFR to hold tool boards and to provide a handhold during EVA satellite repair operations. The tool boards are held in close proximity to the crewmember, who is supported by the foot restraint.

OPERATIONAL COMMENTS

The PFR work station stanchion has a hexagonal probe on the stanchion end that fits into a socket on the PFR. The stanchion pivots about its contact point with the PFR. The tool board holder frame can also be adjusted at 45° increments about the stanchion support. A locking device is provided to secure the tool boards in the desired position. Four mini work station (MWS) fittings are located on the stanchion for attachment of tool caddies or any device with an MWS bayonet fitting. A tether ring near the probe is used when relocating the stanchion. The tool boards are locked in when the lock knob is parallel to the stanchion tube and are free when the knob is horizontal. Ten pounds of force are required to operate the rotation controller.

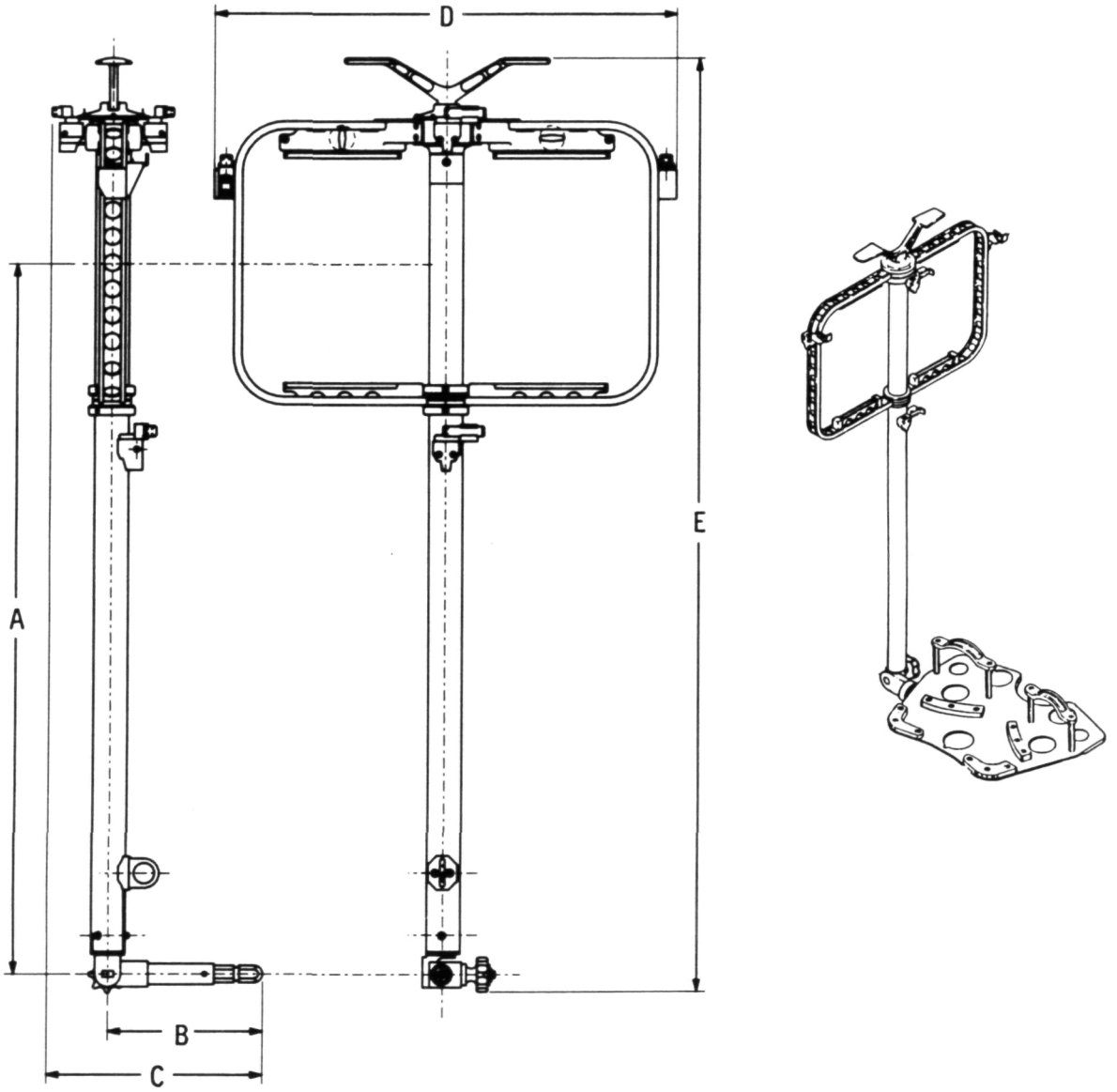
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

PFR WORK STATION STANCHION

Technical Information	
Part number	10176-20004-01
Weight	17.4 lb
Material	Aluminum
Tilt angles	0° to 180° in 15° increments
Rotation angles	360° in 45° increments
Stowage	Starboard bay no. 4 for STS 51-I
Availability	Flight specific

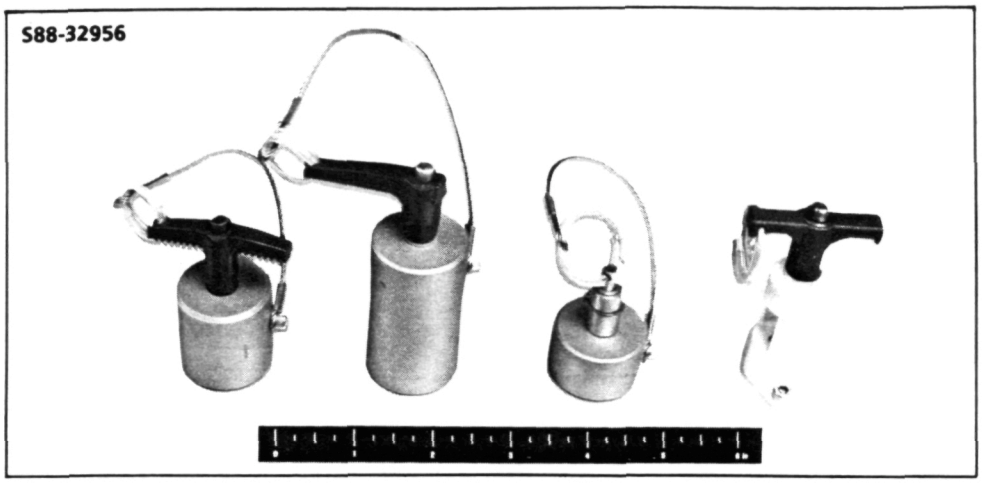
Dimensional Data	
A	42.000 in.
B	9.000 in.
C	12.625 in.
D	27.500 in.
E	55.750 in.



204660168.ART,3

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

PIP PIN



OVERVIEW

The pip pin, also known as a quick release pin, is used as a retaining device to allow frequent and rapid connection, disconnection, or positioning of objects without the use of tools. They are used as a means of containing loose equipment, thus avoiding impacts or loss of the object, and as a positive method of allowing or inhibiting equipment deployment or operation.

Pip pins are made of stainless steel and are available in a variety of standard diameters and grip lengths, with the most common being 1/4 to 3/8 inch in diameter and 3 to 6 inches in length. They have T, L, or ring handles for ease of grasping by a gloved hand, and are held captive to their associated equipment by a tether, lanyard, or retaining ring.

OPERATIONAL COMMENTS

To prevent accidental dislodging of an installed pin, each T and L pin is designed with a safety release button. To remove the pin from its installed position, the safety button must be pushed in as the pin is pulled out. While the button is held down, the pin may be inserted or removed with near-zero force. A return spring acts on the button, not the retaining balls, which are locked rigidly into the extended position until the button is pushed.

Ring handle pip pins are designed so that the ball retaining mechanism can be actuated by pushing the button or pulling the ring while the pin is being installed or removed. This design is easier to install or remove but it can also be inadvertantly snagged and released if located in an exposed area.

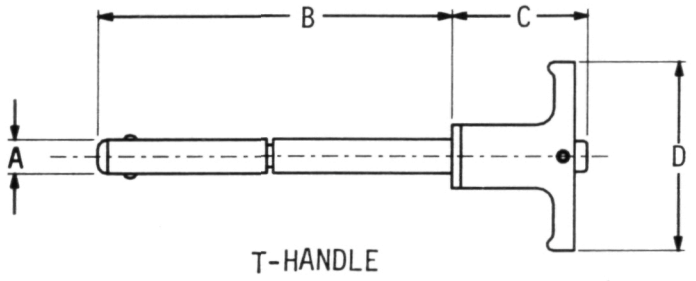
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

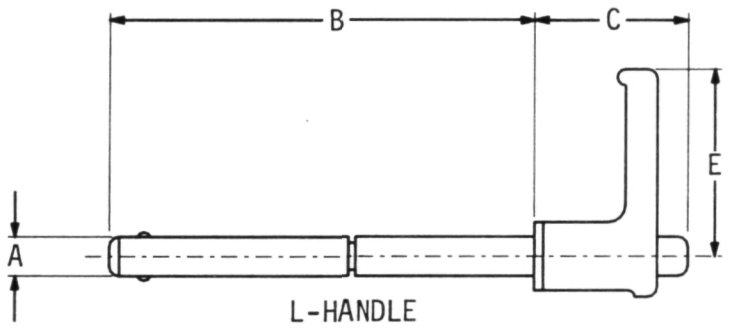
PIP PIN

Technical Information	
Part number	10176-20423-01 (L-handle)
	10173-20143-01 10169-20305-01/02/03 (ring handle)
	10174-20132-01 10174-20146-01 10176-20423-01/02/03 (T-handle)
Weight	0.03 lb (average)
Material	Stainless steel
Operational temperature range	-150 to 250° F
Availability	Flight specific

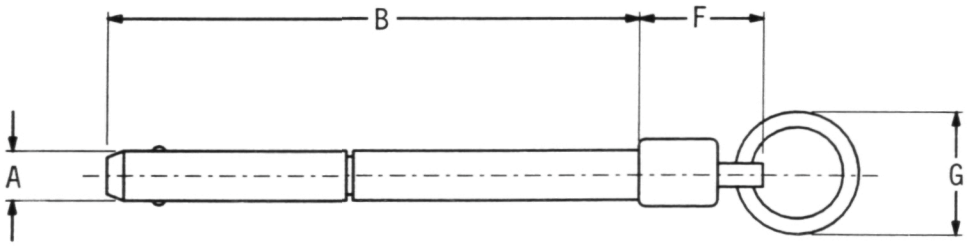
Dimensional Data						
A	B Increments of 0.10	C	D	E	F	G
3/16 1/4 5/16	0.3-9.9 in.	1.272 in.	1.75 in.	1.41 in.	1.017	1.00 in.
3/8 7/16	0.5-9.9 in.	1.449 in.	2.00 in.	1.65 in.	1.065	
1/2 9/16	0.7-9.9 in.		2.25 in.	1.75 in.	1.236	
5/8 3/4	0.9-9.9 in.	1.766 in.	2.50 in.	2.00 in.	1.436	1.00 in.
					1.427	
7/8 1	1.0-9.9 in.	2.062 in.	2.75 in.		1.589	
					1.767	



T-HANDLE



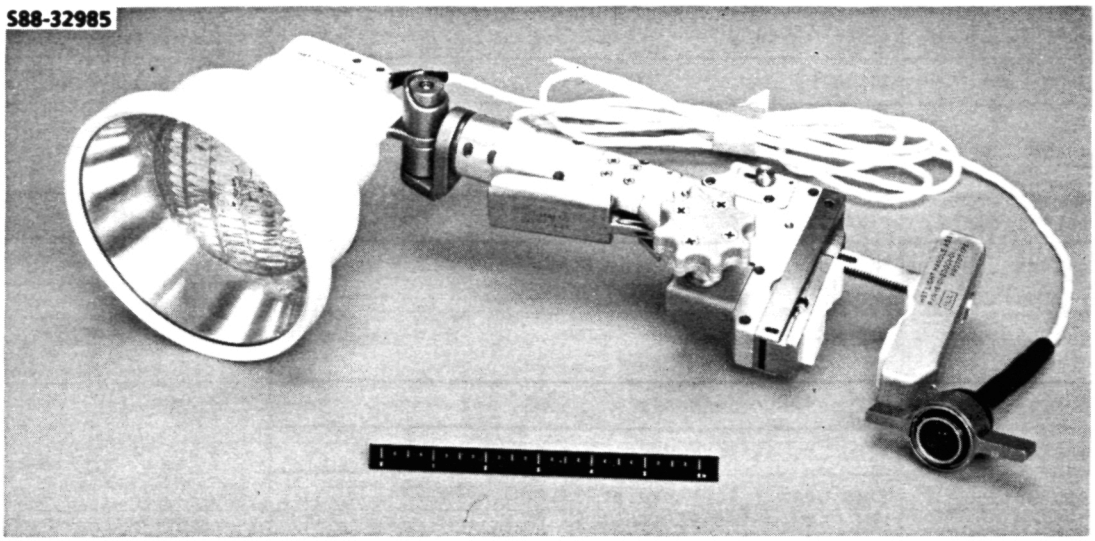
L-HANDLE



204660179.ORT,5

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

PORTABLE FLOOD LIGHT



OVERVIEW

The portable flood light is designed to provide illumination for Hubble Space Telescope (HST) maintenance and repair work. The light consists of a light head and handles which are connected to each other via an EVA compatible two-degree-of-freedom swivel disconnect.

OPERATIONAL COMMENTS

The light head integrates an 8-foot power cord that interfaces with the HST power receptacles. There are two light intensity levels which are selected by the crewmember by use of a toggle switch. The light handle integrates quick-action clamping jaws to allow the assembly to be attached to a common EVA handrail or similar structure. The clamping jaws are covered with elastomer to protect the clamped surface. A 20-foot extension cord is also available for use with this light.

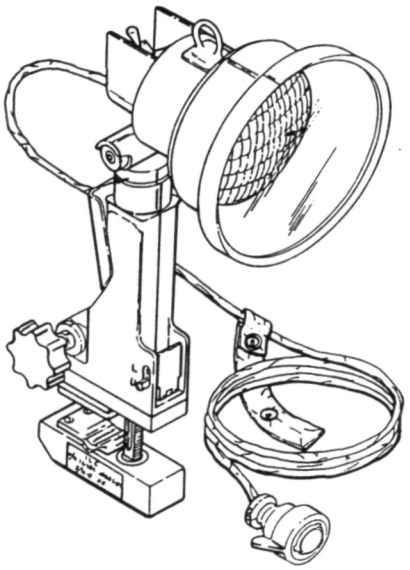
CONTACTS

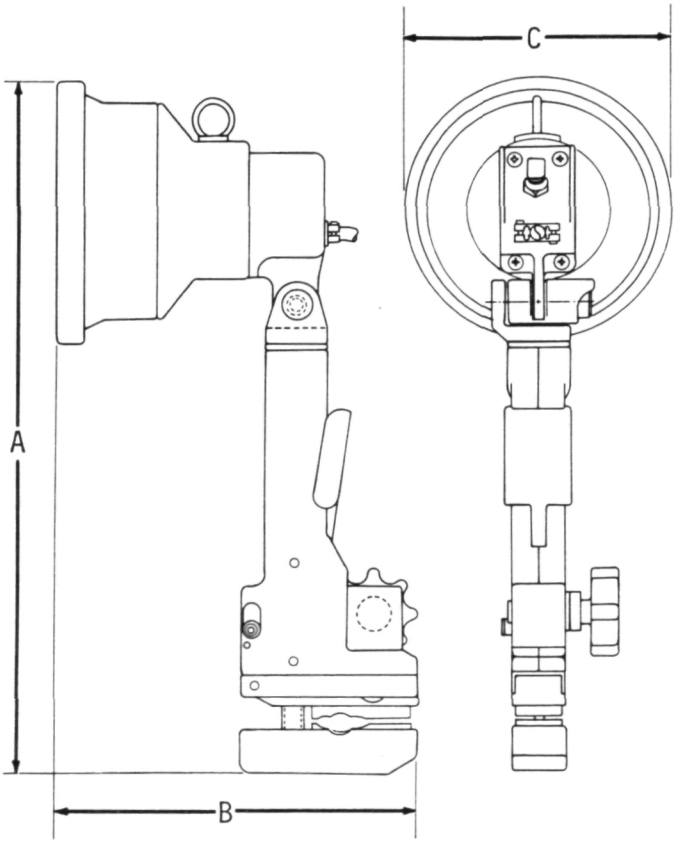
Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

PORTABLE FLOOD LIGHT

Technical Information	
Part number	16101-10061-01
Weight	10 lb
Material/ construction	Aluminum Stainless steel Lexan
Temperature range	-150° to +250° F (operational)
Head rotation	Vertical -45° through +90° Horizontal 360° continuous
Handle extension opening	3/8 to 3-1/2 in.
Power source	HST power receptacle
Power consumption	50 watts at 28 V dc
Light intensity	High beam - 30 ft-cd at 10 ft Low beam - 8 ft-cd at 10 ft
Availability	Flight specific

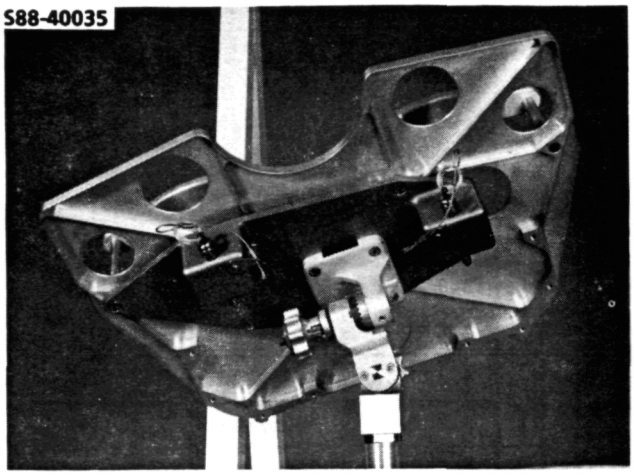
Dimensional Data	
A	15.70 in.
B	8.00 in.
C	6.00 in.

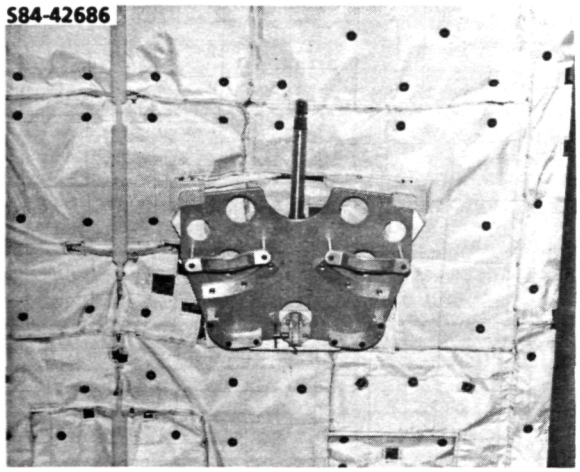




ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

PORTABLE FOOT RESTRAINT





OVERVIEW

The portable foot restraint (PFR) is a working platform which restrains the crewmember during the performance of EVA tasks. The platform consists of a system of toe guides and heel clips which interface with the EMU boots. A two-axis (roll and pitch) gimbal system with lock knobs is provided for adjustment and positioning. A hex-shaped probe enables the PFR assembly to interface with the worksite at a PFR socket, where yaw adjustment is available.

OPERATIONAL COMMENTS

The PFR was originally designed to provide Space Shuttle EVA crewmembers with a contingency restraint system for performing EVA work tasks and door latch repairs on or about the forward and aft bulkhead and along the centerline door latches of the payload bay. As EVA operations increased in frequency, new applications for its use were identified, and improvements were made in the design to minimize setup and adjustment times as well as to increase the operational work load limits from 25 to 100 pounds. Several configurations of the PFR exist, varying in work station mounting socket design and probe lengths, and are capable of attachment to a variety of work surfaces. Spring-loaded lock knobs have also been incorporated into the later configurations to prevent inadvertent unlocking of the gimbal system. One PFR (10159-10034-01) is part of the normally manifested STS equipment. Two PFR styles allow the EVA crewmember to mount one (10176-20060-01) or two (10159-10049-01) work station stanchions to the PFR by the addition of mounting sockets to the foot restraint platform.

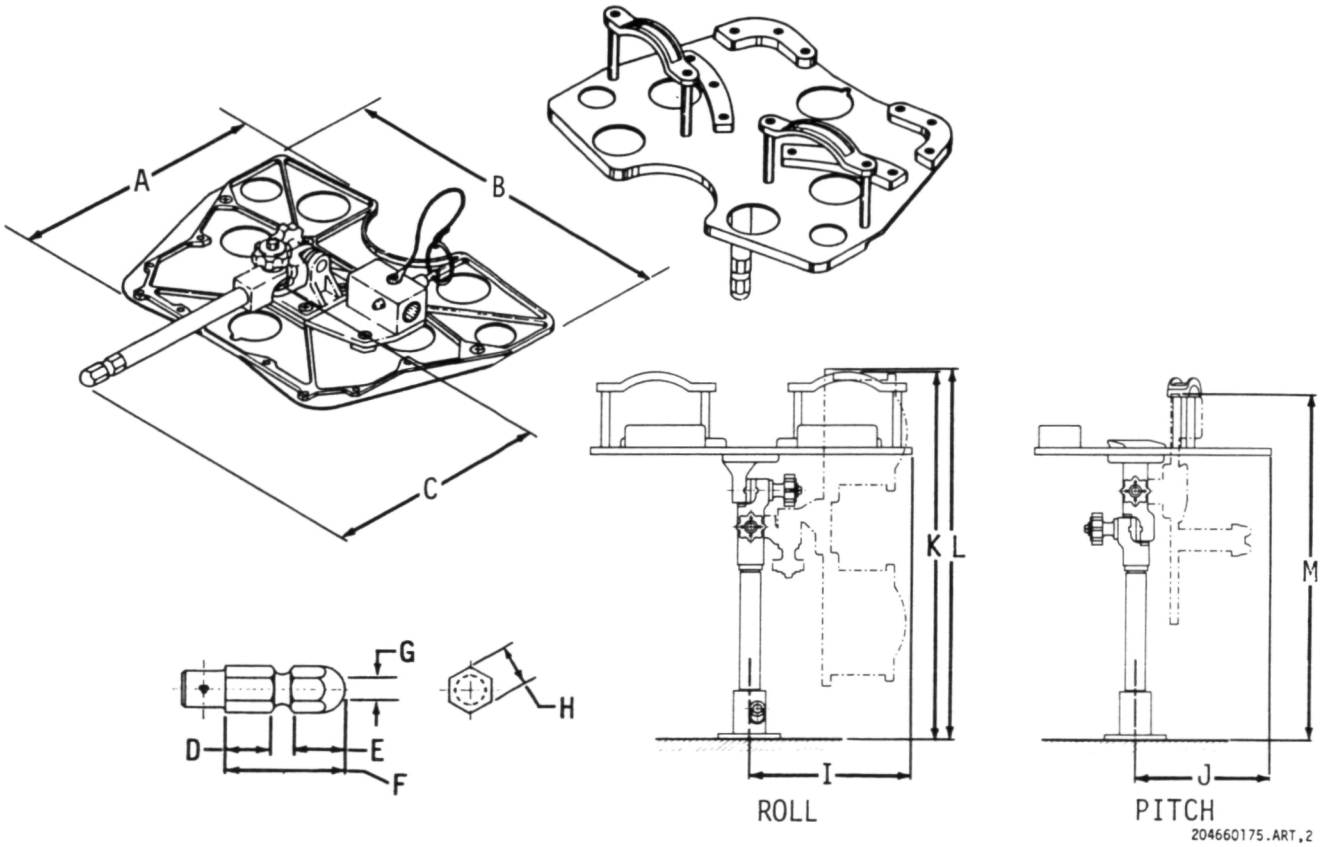
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: M. Withey, ILC Space Systems, (713) 488-9080

PORTABLE FOOT RESTRAINT

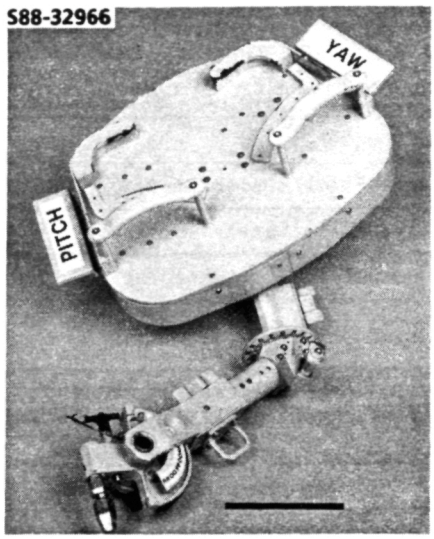
Technical Information	
Part number	10159-10034-01/02 10159-10049-01 10176-20060-01
Weight	8.4 lb (10159-10034-01) 11.4 lb (10176-20060-01)
Material	Aluminum alloy Stainless steel - probe
Input capacity	100 lb in any direction
Quantity flown	One 10159-10034-01
Stowage	Orbiter forward bulkhead
Platform-pitch	-75° to +105° in 15° increments
Platform-roll	± 90° in 15° increments
Platform-yaw	± 360° in 30° increments via 12 pt socket
Availability	10159-10034-01 standard 10159-10034-02 developmental 10159-10049-01 developmental 10176-20060-01 flight specific

Dimensional Data			
	10159-10034-01	10159-10034-02	10159-10049-01 and 10176-20060-01
A	14.800 in.	14.800 in.	14.800 in.
B	20.400 in.	20.400 in.	20.400 in.
C	13.150 in.	27.300 in.	13.150 in.
D	1.080 in.	1.080 in.	1.080 in.
E	1.300 in.	1.300 in.	1.300 in.
F	2.750 in.	2.750 in.	2.750 in.
G	0.650 in.	0.650 in.	0.650 in.
H	0.999 in.	0.999 in.	0.999 in.
I	10.200 in.	10.200 in.	10.200 in.
J	8.400 in.	8.400 in.	8.400 in.
K	22.560 in.	36.710 in.	22.940 in.
L	23.350 in.	37.500 in.	23.730 in.
M	19.550 in.	33.700 in.	19.930 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

PORTABLE FOOT RESTRAINT (HST)



OVERVIEW

The portable foot restraint (PFR) for the Hubble Space Telescope (HST) is a working platform which allows the EVA crewmember to perform HST servicing tasks which would be difficult without a solid platform. The foot restraint assembly consists of a foot platform, boom, and mounting stud. The foot platform has yaw and pitch controls which can be operated by the crewmember's foot. The foot restraint can also be elevated and rolled to a desired location.

OPERATIONAL COMMENTS

The HST PFR is provided to aid the EVA crewmembers in space telescope maintenance activities. Numerous PFR sockets are located at various locations on the HST to allow PFR mounting at any desired work station along the vehicle.

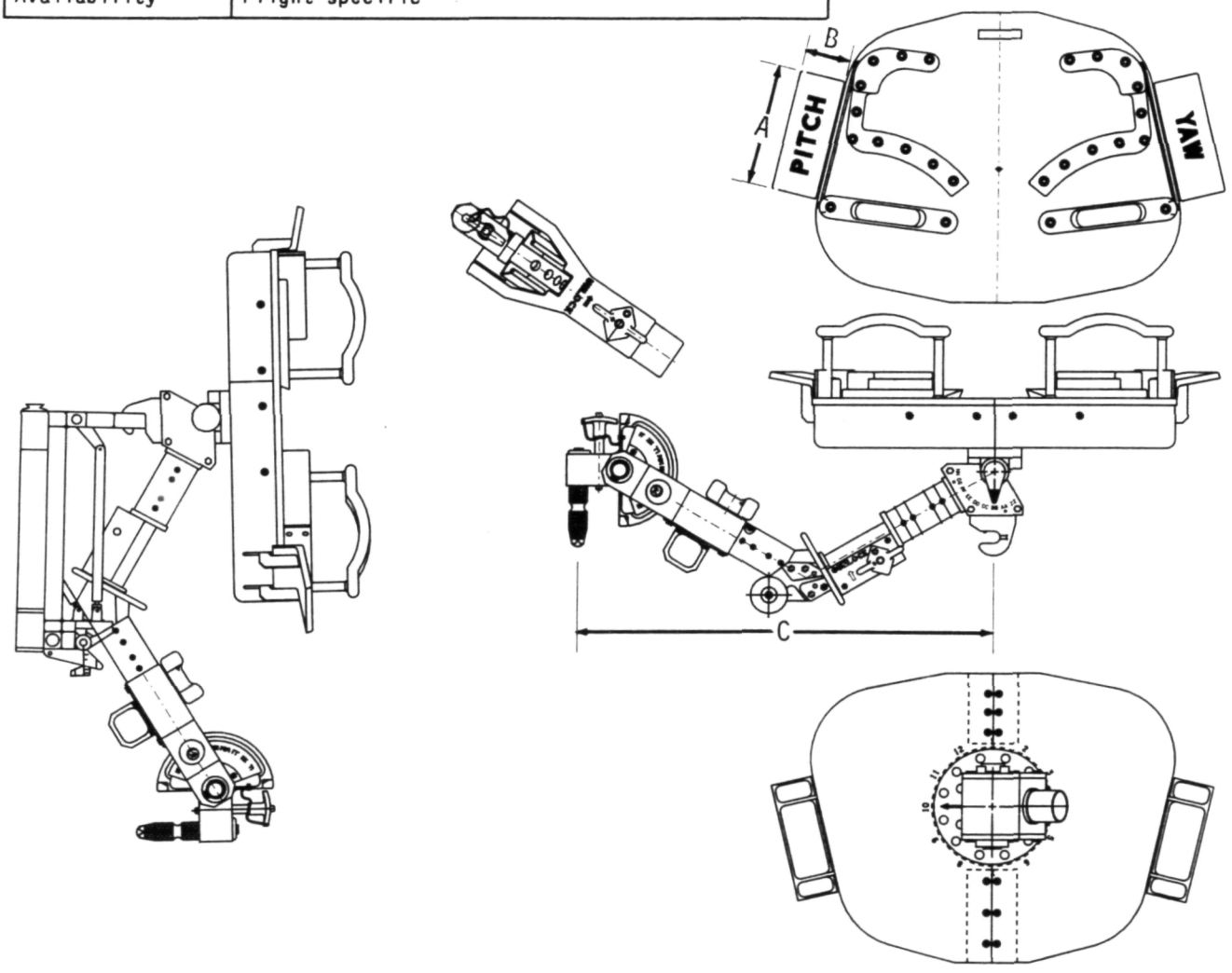
CONTACTS

Operational: S. P. Boyd, NASA/DF42, (713) 483-1755
Technical: R. Sheffield, LMSC/DEPT 64-10, (408) 742-8464
Source: LMSC, HST Contracts Office, (408) 742-5505

PORTABLE FOOT RESTRAINT (HST)

Technical Information	
Part number	4177097
Weight	45.4 lb
Material	Aluminum and steel
Roll positions	0° to 340° in 20° increments (A-S)
Yaw positions	0° to 330° in 30° clockwise increments (1-12)
Pitch positions	Up 30° to down 90° in 15° increments (ZZ-HH)
Elevation positions	Up 90° to down 30° in 15° increments (JJ-RR)
Stowage	Adaptive payload carrier using standard manipulator foot restraint latch and roller system
Availability	Flight specific

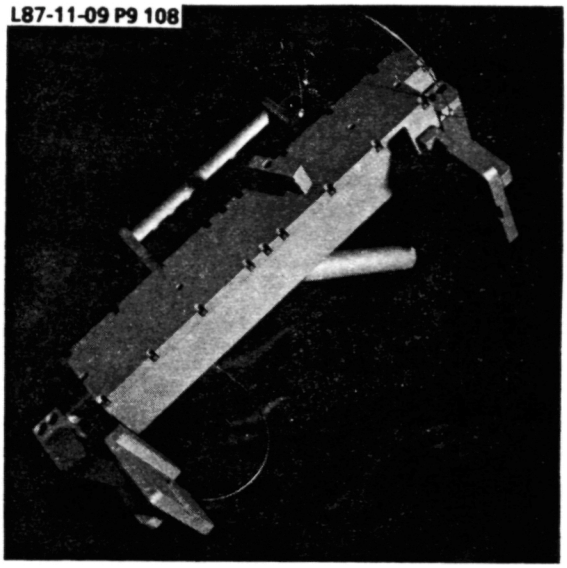
Dimensional Data	
A	6.70 in.
B	2.40 in.
C	23.40 in.



204660113. ORT, 5

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

PORTABLE ORU HANDLE, LARGE



OVERVIEW

The large portable ORU handle is an infinitely adjustable latch-on handle designed to provide the astronaut with a convenient and safe means of handling the electronic black boxes of the Hubble Space Telescope (HST) should they need replacement while on orbit.

OPERATIONAL COMMENTS

The handle is a ratcheting, linear clamping device designed to mate with typical spacecraft electronic boxes. The device employs a double telescoping rack and pinion drive for a quick acting, highly compact design, a high resolution ratchet mechanism for locking, and silicon rubber grip pads to provide compliance and gripping friction.

Operation of the device involves two processes, selection of mode (LOCK or UNLOCK) and rotation of crank handle. Mode selection either engages or neutralizes the ratchet mechanism. In the LOCK mode, the crank handle can only be turned to tighten the device. In the UNLOCK mode the clamps can be extended or retracted. The device is available in two configurations (large and small) which cover a grip range from 11 to 32 inches.

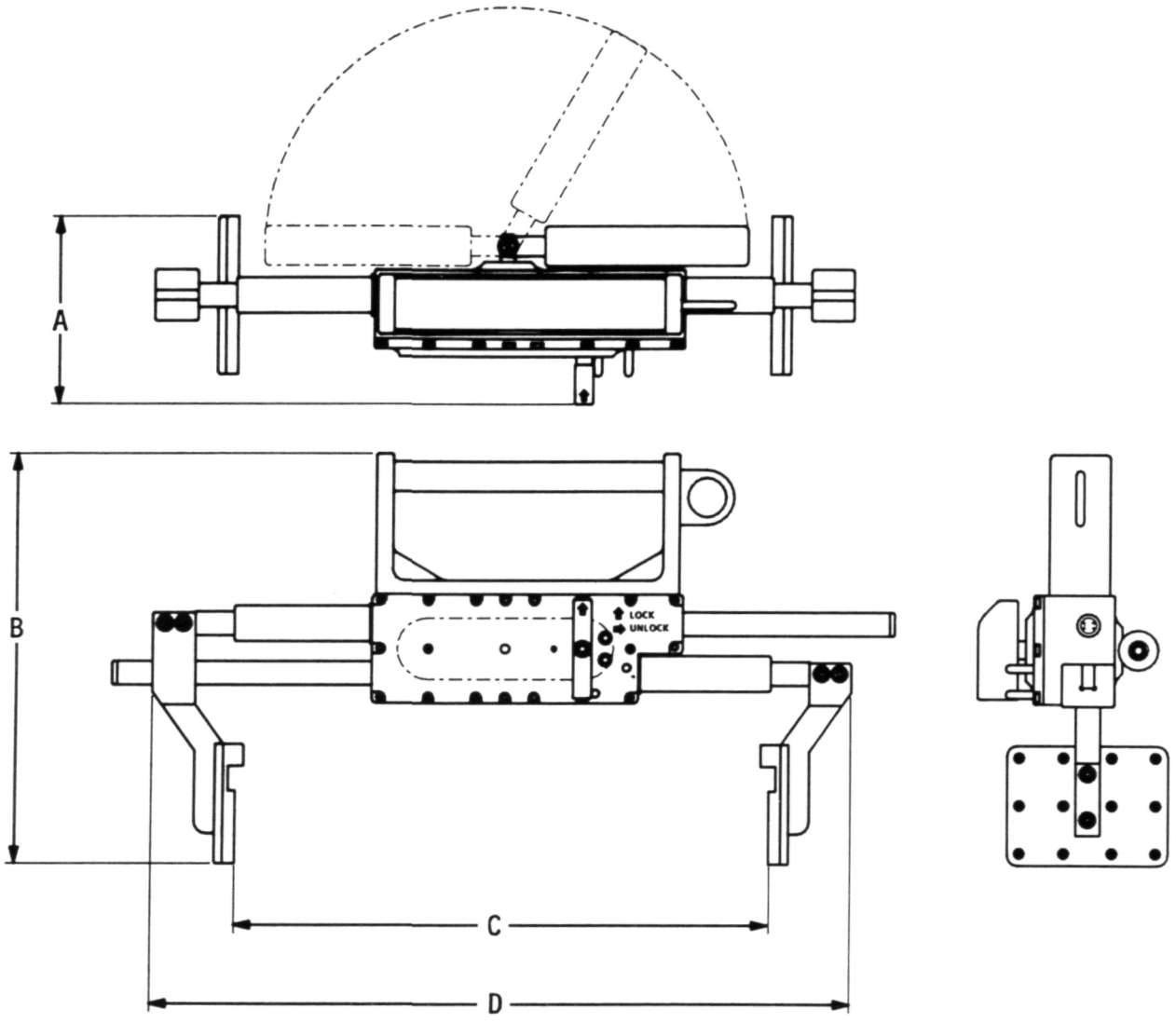
CONTACTS

Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: J. W. Redmon, MSFC EP65, (205) 544-7136
Source: J. W. Redmon, MSFC EP65, (205) 544-7136

PORTABLE ORU HANDLE, LARGE

Technical Information	
Part number	SET97M22926-1
Weight	Not available
Material/ construction	Handle cushion - RTV
Temperature range	-150° to +250° F (operational)
Availability	Flight specific

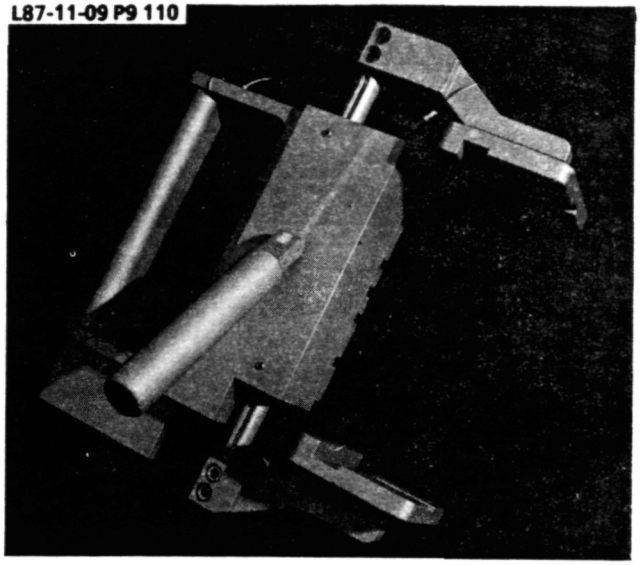
Dimensional Data	
A	4.80 in.
B	10.35 in.
C	11.70-32.00 in.
D	18.53-35.92 in.



204660333.ART,2

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

PORTABLE ORU HANDLE, SMALL



OVERVIEW

The small portable ORU handle is an infinitely adjustable latch-on handle designed to provide the astronaut with a convenient and safe means of handling the electronic black boxes of the Hubble Space Telescope (HST) should they need replacement while on orbit.

OPERATIONAL COMMENTS

The handle is a ratcheting, linear clamping device designed to mate with typical spacecraft electronic boxes. The device employs a double telescoping rack and pinion drive for a quick acting, highly compact design, a high resolution ratchet mechanism for locking, and silicon rubber grip pads to provide compliance and gripping friction.

Operation of the device involves two processes, selection of mode (LOCK or UNLOCK) and rotation of crank handle. Mode selection either engages or neutralizes the ratchet mechanism. In the LOCK mode, the crank handle can only be turned to tighten the device. In the UNLOCK mode the clamps can be extended or retracted. The device is available in two configurations (large and small) which cover a grip range from 4 to 14 inches.

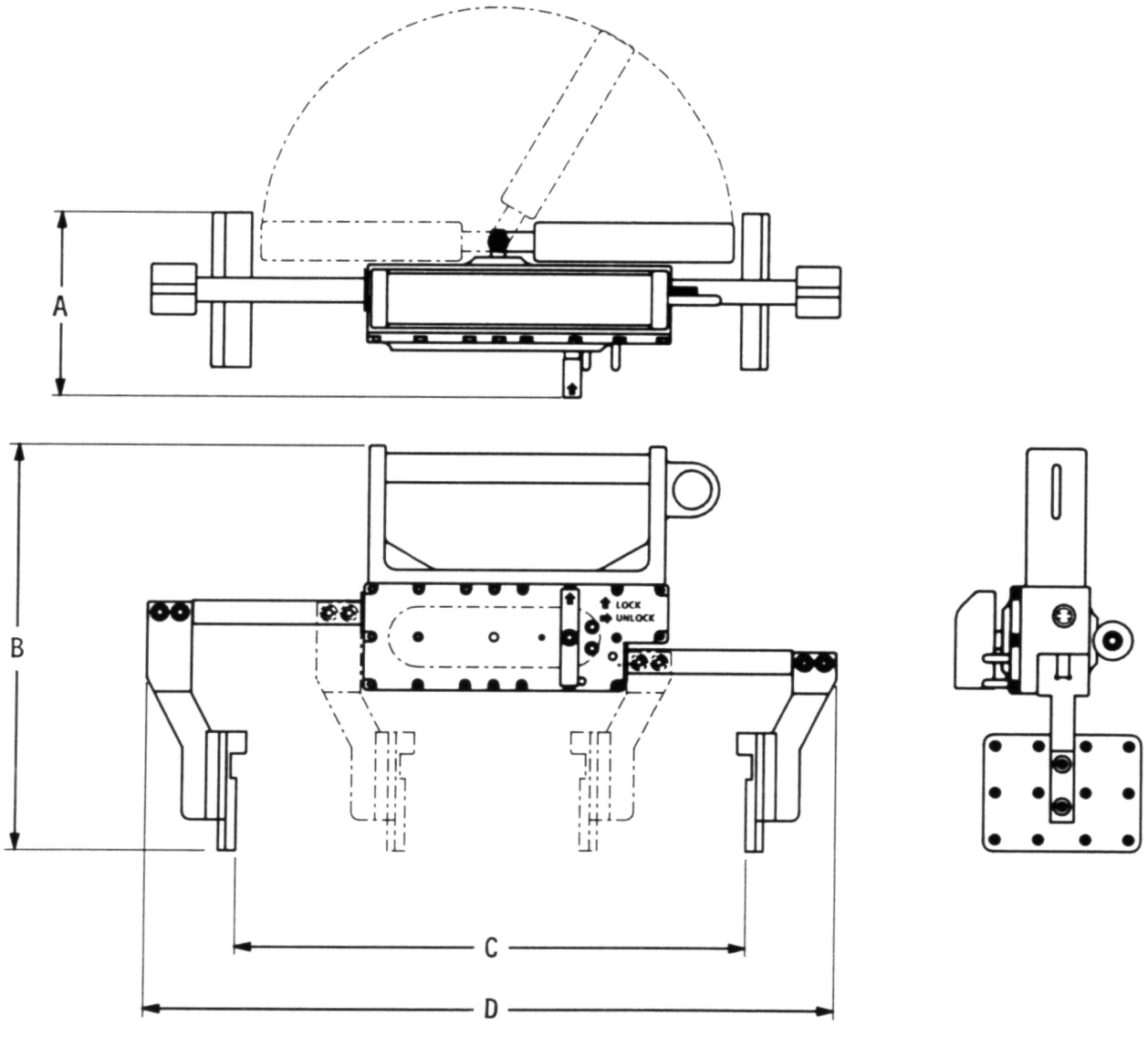
CONTACTS

Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: J. W. Redmon, MSFC EP65, (205) 544-7136
Source: J. W. Redmon, MSFC EP65, (205) 544-7136

PORTABLE ORU HANDLE, SMALL

Technical Information	
Part number	SET97M22763-1
Weight	Not available
Material/ construction	Handle cushion - RTV
Temperature range	-150° to +250° F
Availability	Flight specific

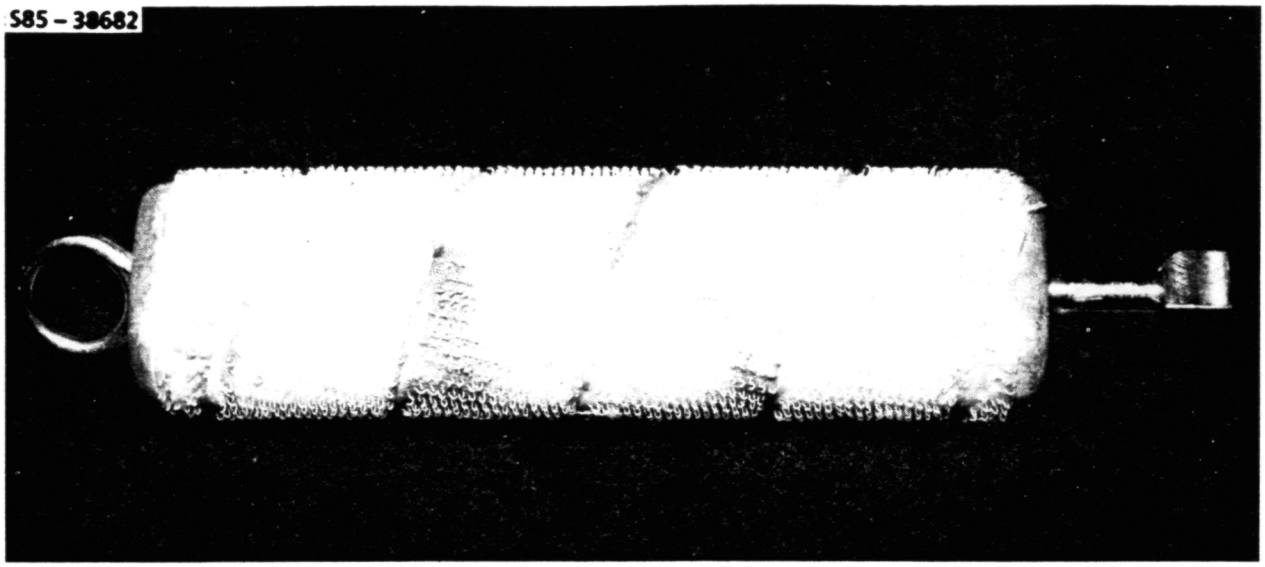
Dimensional Data	
A	4.80 in.
B	10.35 in.
C	4.48-14.30 in.
D	9.03-18.85 in.



204660222.ART,2

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

POWER DRIVE UNIT DISCONNECT



OVERVIEW

The power drive unit (PDU) disconnect tool is a 3/8-inch square drive extension with a Velcro-wrapped handle and an attached tether ring. The drive extension extends 1 inch from the handle and has a smooth 3/8-inch cube on the end. This tool is part of the normally manifested STS equipment. It is wrapped in a Velcro-lined caddy with the loop pin extractor and stowed in the starboard provisions stowage assembly (PSA).

OPERATIONAL COMMENTS

If the payload bay doors will not close, the PDU disconnect is used to disengage the PDU from the PDU torque shaft, allowing the torque shaft to be rotated so the payload bay doors can be winched shut.

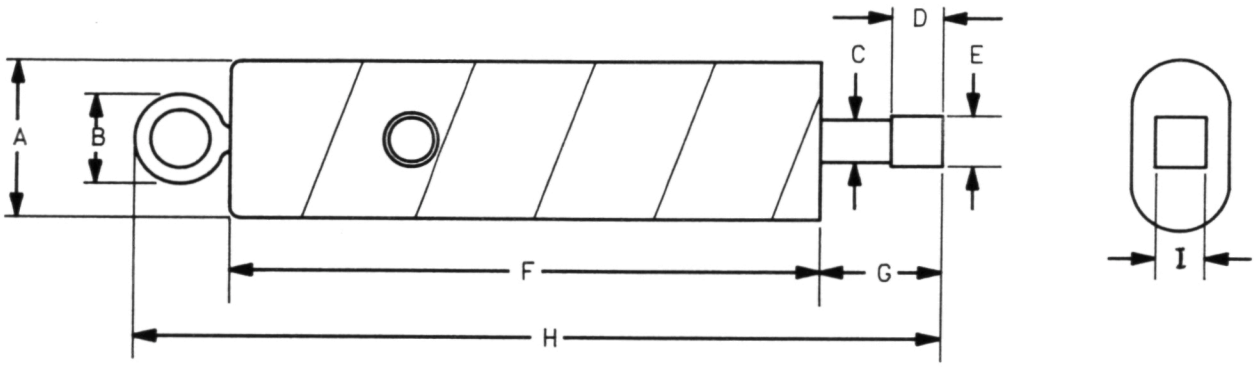
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: J. Madden, Rockwell/Houston, (713) 282-5300

POWER DRIVE UNIT DISCONNECT

Technical Information	
Part number	V628-651001-001 or SDD33103442-301
Weight	0.5 lb
Material	Handle - aluminum Drive - tool steel
Temperature range	-200° to 250° F (operational)
Quantity flown	One in the starboard PSA
Availability	Standard

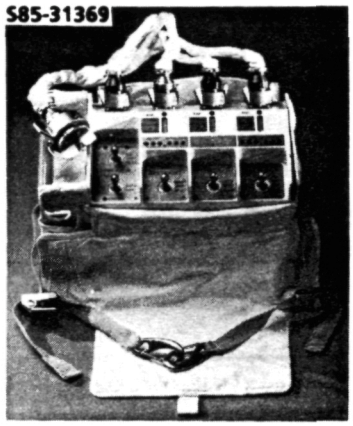
Dimensional Data	
A	1.350 in.
B	0.750 in.
C	0.300 in.
D	0.375 in.
E	0.375 in.
F	5.000 in.
G	1.000 in.
H	6.750 in.
I	0.375 in.



204660116.ART;3

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

POWER PACKAGE, EVA



OVERVIEW

The EVA power package (EPP) is a portable, direct-current power supply designed for specific, as well as general purpose, applications. Currently, it is configured for payload assist module D (PAM-D) operations.

OPERATIONAL COMMENTS

The EPP provides 28-volt, 6.0-A dc power with four bipolar output circuits, each of which has a built-in overcurrent interrupter externally selectable at 3.5 A, 5.5 A, or 6.5 A. The output circuits can be externally set as four independent circuits or four exclusive circuits in which one energized circuit excludes the activation of a second circuit. Three of the four circuits provide a current bar graph meter externally selectable for 2.0 A, 5.0 A, or 7.0 A full scale.

System level includes main power ON/OFF, a self-test sequence to confirm system operation under a simulated load, a backup overcurrent interrupter set at 6.8 A, and an overheat warning mechanism. Control for each circuit is via a three-position, lift-to-unlock toggle switch for outputting forward polarity 28 volts, off selection and reverse polarity 28 volts. ON/OFF 28-volt inputs are received and annunciated, and remote power cutoff capability is provided.

Input/output for each circuit is via a 19-pin, aerospace circular connector. Labels to indicate the function of each switch position can be replaced for different mission applications. The EPP hardware includes a handgrip, two adjustable tethers, and a passive thermal protection for a 6-hour EVA.

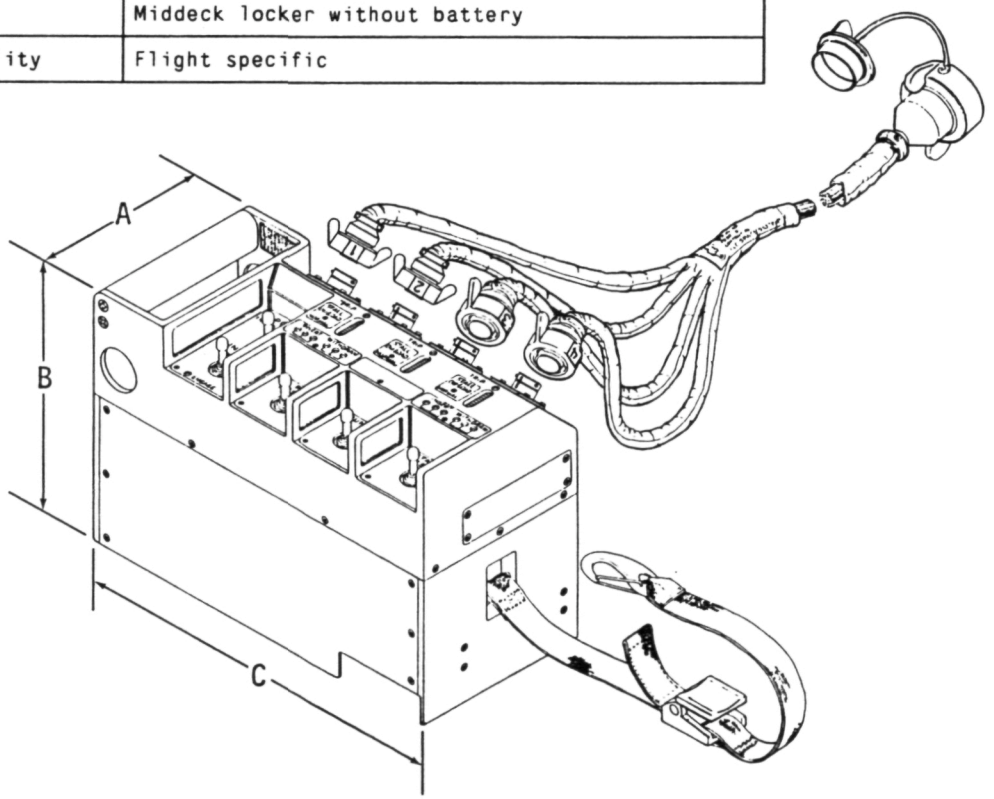
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

POWER PACKAGE, EVA

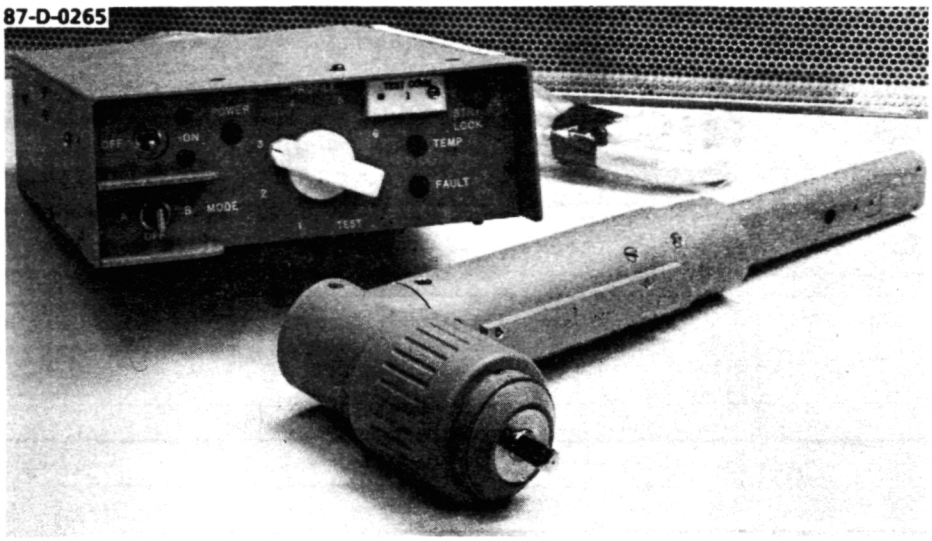
Technical Information	
Part number	10175-10075-02
Weight	27 lb (without battery)
Continuous output capability	28 V dc ± 2 V dc, 6 A
Surge capability	8.0A without instantaneous tripping
Capacity	Up to 10 A-hr
Overcurrent interrupt settings	3.5, 5.5, 6.5 A externally selectable
Current bar graph meter settings	2.0 A, 5.0 A, 7.0 A externally selectable
Max. battery temp for 12 min	115° F
Max. temp for 1 hr 10 min operation	160° F
Battery	26.6 Amp-hr EMU (see EMU battery)
Thermal protection garment material	Ortho, Teflon fabrics, aluminized mylar, and polyester scrim
Quantity flown	One for STS 51-I
Stowage	Middeck locker without battery
Availability	Flight specific

Dimensional Data	
A	6.3 in.
B	9.4 in.
C	13.0 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

POWER RATCHET TOOL



OVERVIEW

The power ratchet tool (PRT) is a self-contained, power-driven, 3/8-inch drive ratchet tool for extravehicular use. It is intended for use to deploy the Hubble Space Telescope (HST) solar arrays should the automatic mechanism fail.

OPERATIONAL COMMENTS

The PRT is battery powered and is controlled by a dedicated electronic controller, which is designed to be carried on the crewmember's mini work station. Fourteen discrete combinations of torque, turn, and speed may be programmed prior to the mission. The crewmember controls these parameters of the tool by a switch mounted on the controller. A trigger, located on the handle, is the start/stop control for the tool (not shown in above picture). The tool may also be used in a manual mode similar to a nonpowered ratchet wrench. The direction of the ratcheting action may be changed by the crewmember using an external switching ring surrounding the gearhead/ratchet assembly. The silver-zinc battery module is replaceable during an EVA.

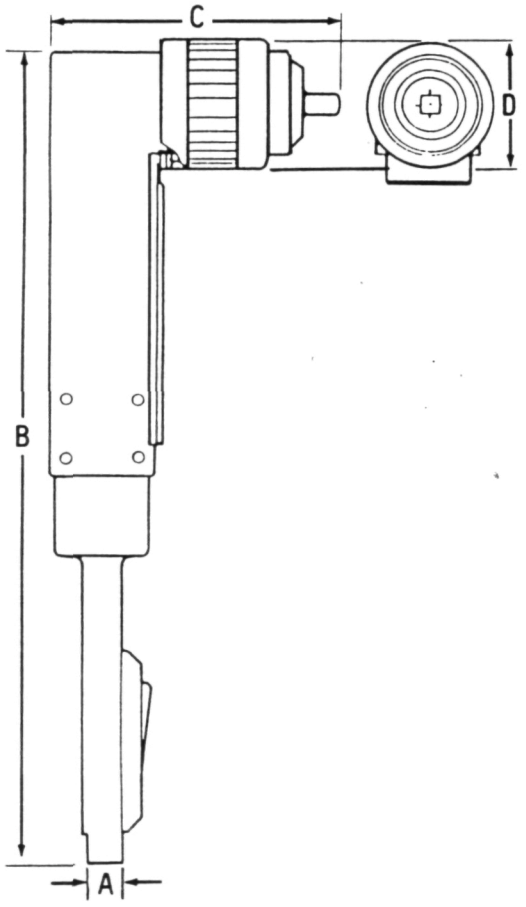
CONTACTS

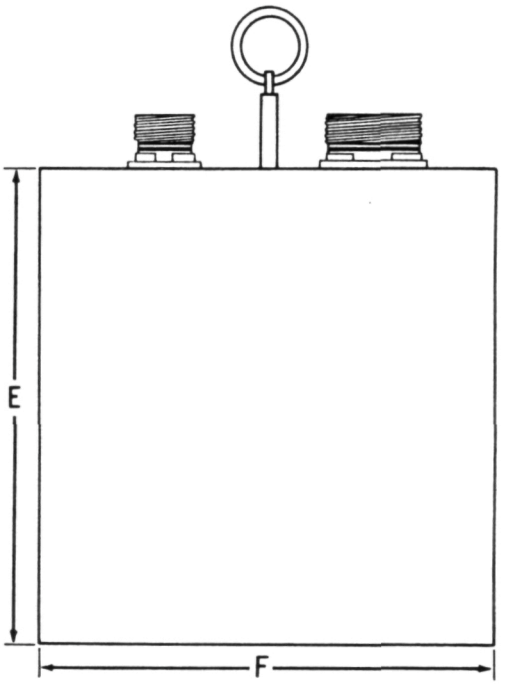
Operational: S. Boyd, NASA/DF42, (713) 483-1775
Technical: Capt. B. McCandless II, NASA/CB, (713) 483-2712
Source: K. Olson, NASA/GSFC, (301) 286-3230

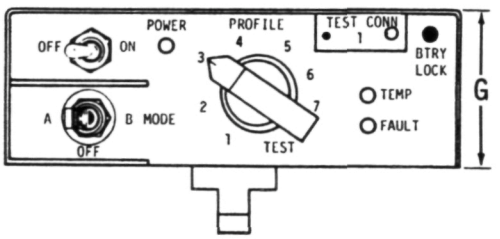
POWER RATCHET TOOL

Technical Information	
Part number	Not available
Weight Ratchet assembly Controller Battery module	 8.5 lb 4.0 lb 3.0 lb
Operating torque: Maximum manual Normal operating	 75 ft-lb 25 ft-lb
Programmable parameters Torque Turns Speed	 1.0 to 25 ft-lb (increments of 1.0) 0.25 to 54.75 (increments of 0.25, 0.5, or 0.75) 10 to 50 rpm
Power supply	28 V dc silver-zinc battery
Cable length	4 ft
Availability	Flight specific

Dimensional Data	
A	0.75 in.
B	15.90 in.
C	5.45 in.
D	2.50 in.
E	9.65 in.
F	8.20 in.
G	2.97 in.

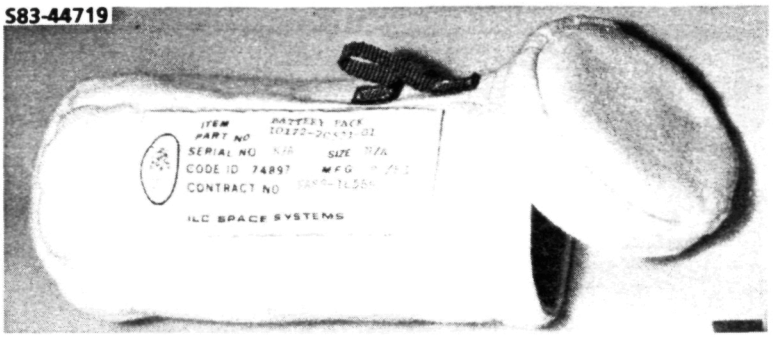






ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

POWER TOOL BATTERY BAG, EVA



OVERVIEW

The EVA power tool battery bag is a protective container provided for the storage and transfer of the EVA power tool battery to the worksite. It is fabricated from two layers of Nomex and uses Velcro to secure the lid and to provide restraint straps. Two small tabs are located on the lid to facilitate opening the bag.

OPERATIONAL COMMENTS

The EVA power tool battery and bag are manifested together. The battery is removed from the bag by pulling open the lid. The battery is then inserted in the back of the EVA power tool and the bag is stowed.

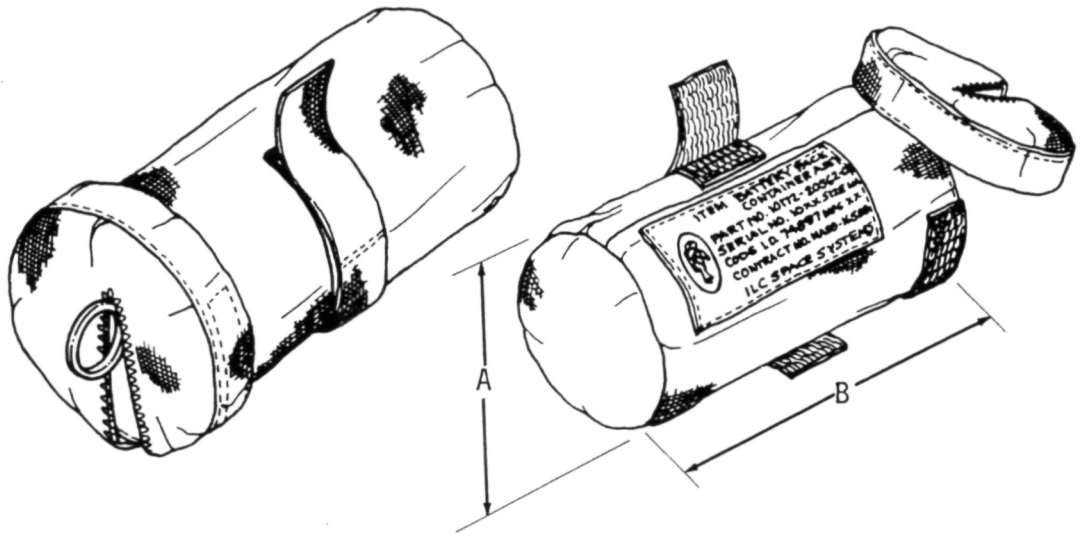
CONTACTS

Operational: S. Boyd, NASA/DF42, (713) 483-1775
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

POWER TOOL BATTERY BAG, EVA

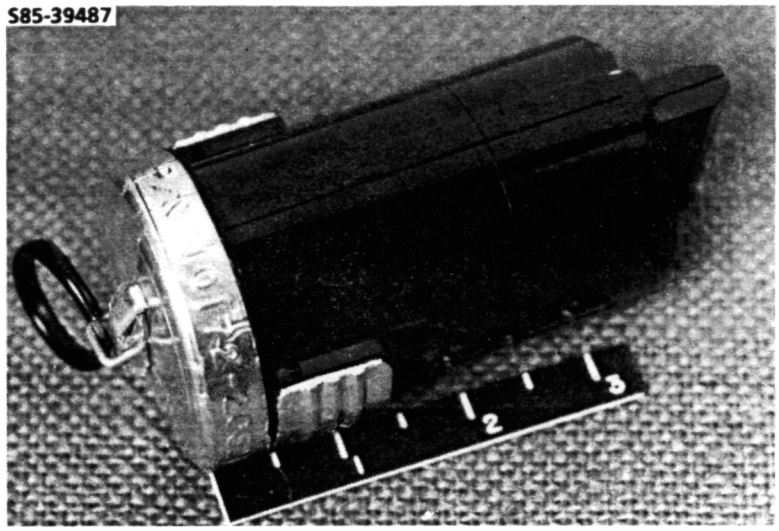
Technical Information	
Part number	10172-80004-01 10172-20562-01 (battery pack container assembly, consists of battery and bag)
Weight	0.086 lb
Material/ construction	Nomex duck Velcro
Temperature range	-150° to +250° F (operational)
Availability	Flight specific

Dimensional Data	
A	2.75 in.
B	5.50 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

POWER TOOL BATTERY, EVA



OVERVIEW

The EVA power tool battery is a six-celled nickel-cadmium power pack for the EVA power hand tool.

OPERATIONAL COMMENTS

The EVA power tool battery inserts into the back end of the power hand tool and locks into place. The base of the battery has an attached tether ring. Internally, six sub "C" nickel-cadmium cells are arranged in two individual circuits, each of which consists of three cells connected in series. Each circuit has an in-line 30-A fuse which interrupts power in case of a fault. When installed in an EVA power tool, the battery provides 3.6 V dc in low speed mode and 7.2 V dc in high speed mode. Three battery packs are normally manifested and stowed in the middeck for launch. A thermal bag is provided for transfer of the battery to the EVA power tool worksite.

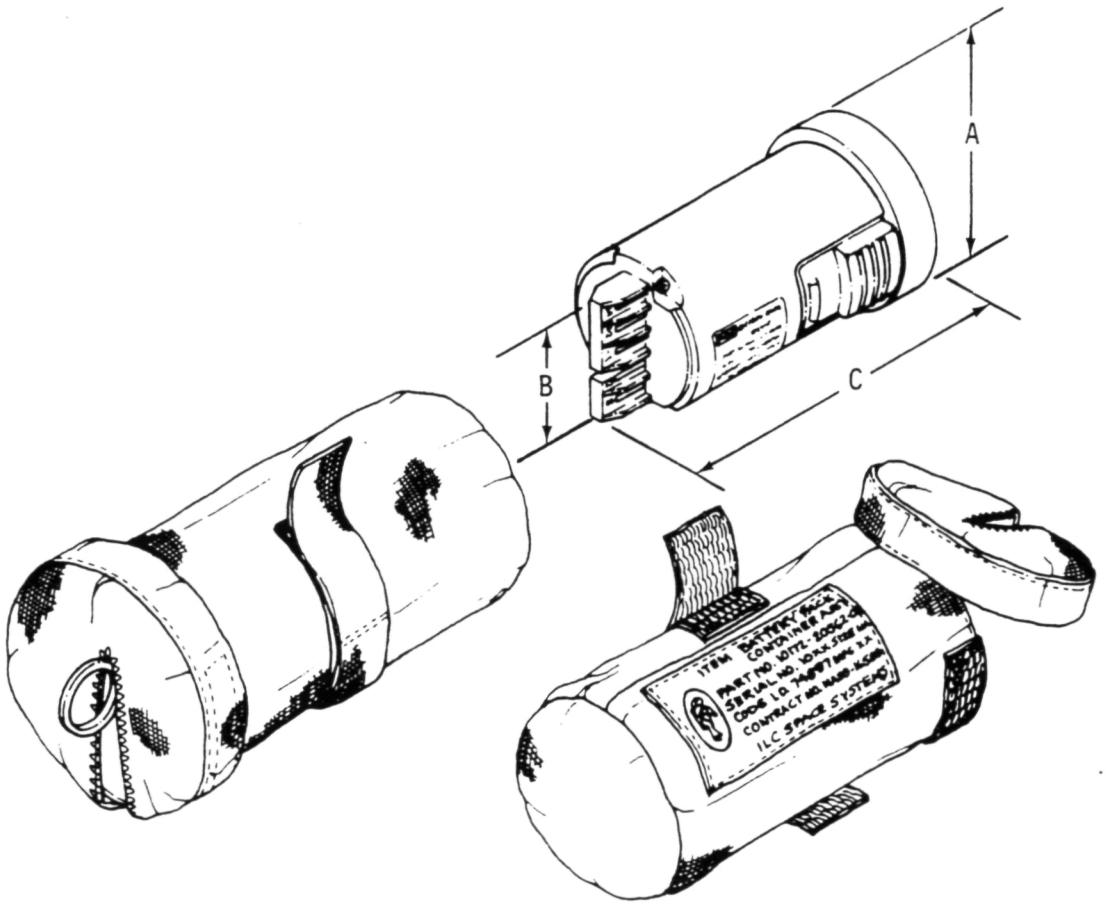
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

POWER TOOL BATTERY, EVA

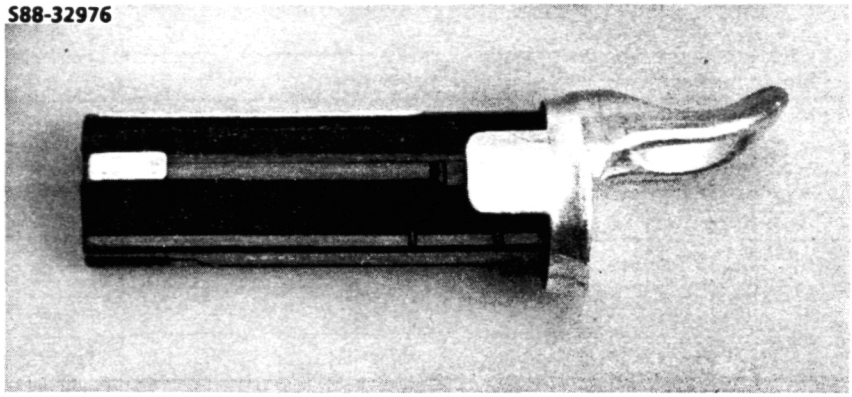
Technical Information	
Part number	10172-20521-02
Weight	0.83 lb
Material	Plastic case, nickel-cadmium cells
Fuse	30 A
Amp-hour	1.7 A-h
Voltage	3.6 V dc (low speed), 7.2 V dc (high speed)
Quantity flown	Three
Stowage	Middeck locker
Availability	Flight specific

Dimensional Data	
A	2.250 in.
B	1.680 in.
C	4.625 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

POWER TOOL BATTERY, MINI



OVERVIEW

The mini power tool battery is a two-celled nickel-cadmium power pack for the mini power tool.

OPERATIONAL COMMENTS

The mini power tool battery inserts in the back end of the mini power tool and locks into place. The base of the battery has an attached tether ring. Internally, two sub "C" nickel-cadmium cells are connected in series with an inline 30-amp fuse for short circuit interruption.

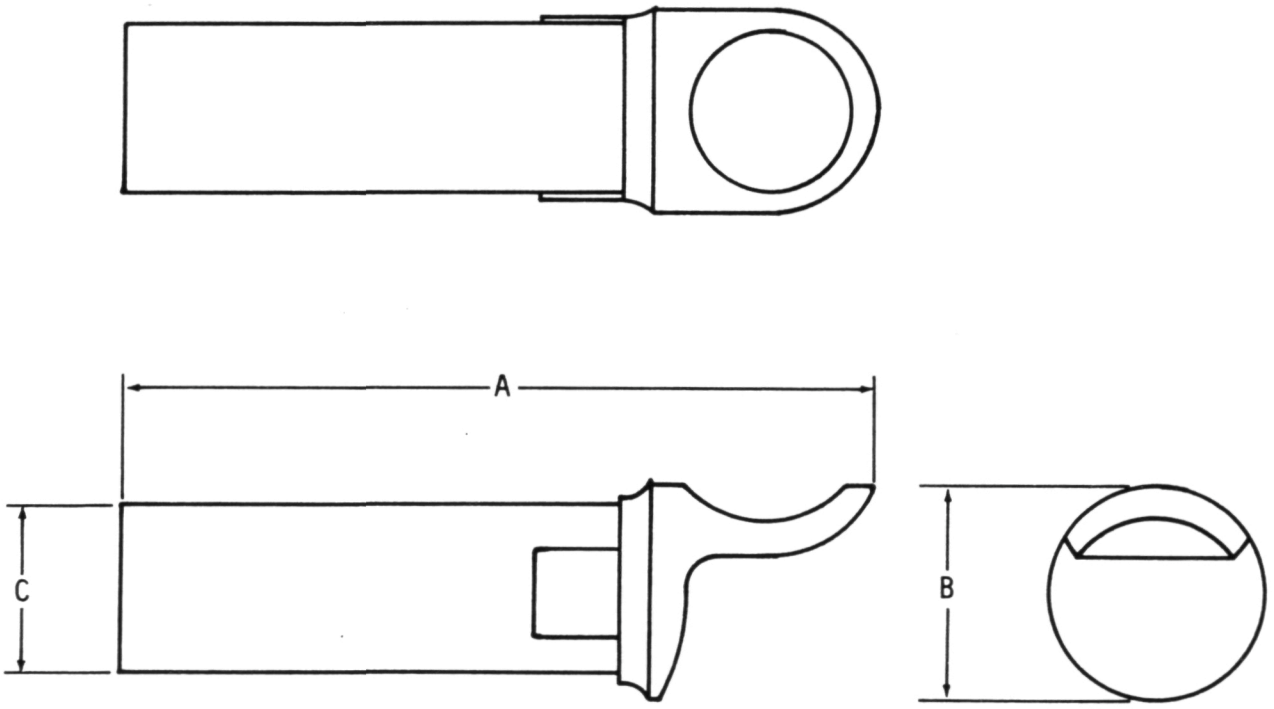
CONTACTS

Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

POWER TOOL BATTERY, MINI

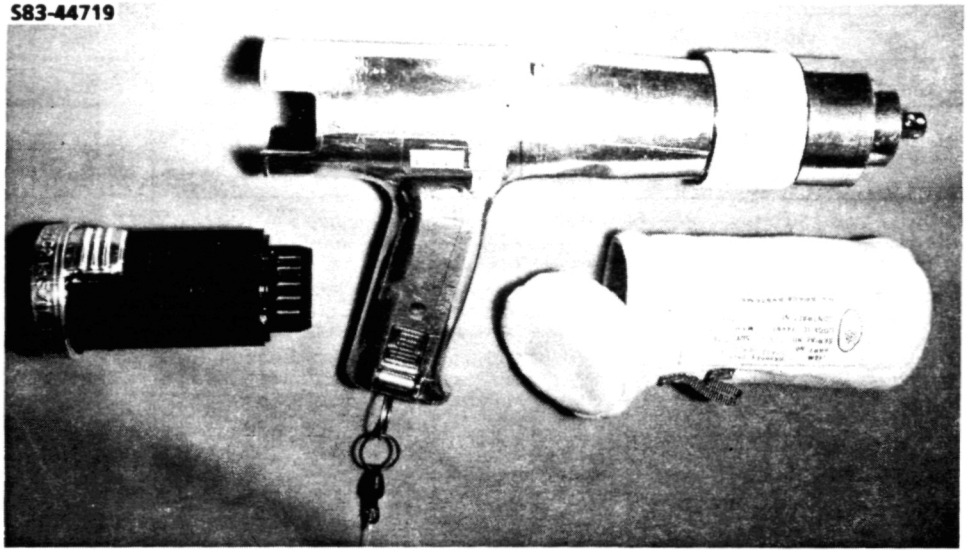
Technical Information	
Part number	10135-20001-01
Weight	0.28 lb
Material/ construction	Tapes - Kapton embossing aluminum Battery pack - plastic case NiCd cells
Temperature range	-130° to +150° F (operational)
Power output	2.4 V dc, 1.7 A-hr
Fuse	30 A
Availability	Developmental

Dimensional Data	
A	5.380 in.
B	1.500 in.
C	1.188 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

POWER TOOL, EVA



OVERVIEW

The EVA power tool is a battery-powered, two-speed/four-torque unit with a 3/8-inch drive drop-proof tether fitting for attaching tools such as screwdrivers, sockets, and drill bits. It has a two-speed switch, a four-position torque control ring, and a forward/reverse switch. Power is provided by a 7.2-volt NiCd rechargeable battery which fits into the tool's back end.

OPERATIONAL COMMENTS

The EVA power tool can be used for any EVA task that requires a portable torque device for tightening/loosening bolts, drilling, or assisting in any manual cranking. Normally one power tool is stored in a middeck locker along with several battery packs to allow pre-EVA checkout. A second power tool without a battery can be stored in the payload bay.

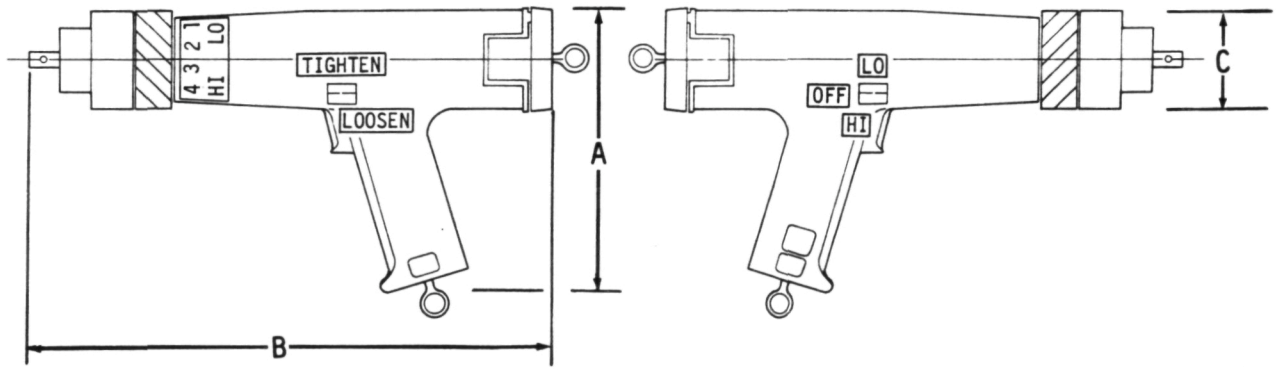
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

POWER TOOL, EVA

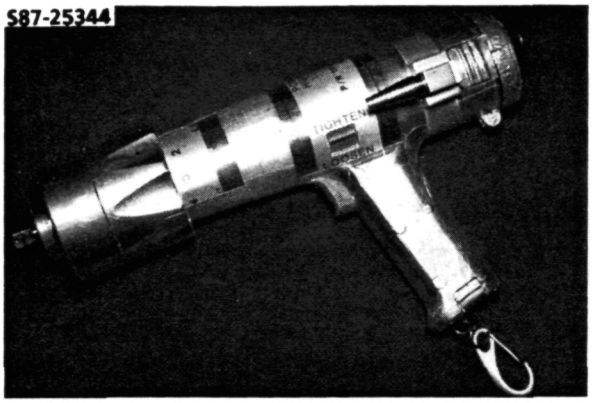
Technical Information	
Part number	10172-20500-01
Weight	2.09 lb (without battery)
Material/ construction	Case - glass-filled lexan body, polyimide gear housing covered with reflective aluminum tape Battery pack - 7.2 V NiCd
Speed	50 rpm, 100 rpm (with low torque loads)
Direction	Forward/reverse (tighten/loosen)
Capacity	375 to 450 screws/battery pack
Stall torque values (in-lb)	Low speed: Position 1: Tighten 15, Loosen 15; Position 2: 29, 27; Position 3: 54, 40; Position 4: 166, 150 High speed: Position 1: 10, 12; Position 2: 26, 20; Position 3: 41, 34; Position 4: 192, 175
Availability	Flight specific

Dimensional Data	
A	6.50 in.
B	11.75 in.
C	2.25 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

POWER TOOL, EVA (HST)



OVERVIEW

This EVA power tool is a modified, battery-operated power tool with torque and rpm control. The clutch torque is controlled by use of a serrated adjustment ring. The design includes a 3/8-inch drive drop-proof tether fitting, forward and reverse drive rotation, torque ranges from 50 to 300 in-lb in four clutch positions, a bayonet fitting which allows attachment of the tool to the mini work station, a tether point on the removable battery pack, and a 6-foot retracting tether with a french hook in the tool handle. This tool was developed for use in Hubble Space Telescope (HST) maintenance.

OPERATIONAL COMMENTS

The crewmember has three choices to make in the operation of this tool: torque limit, direction, and rpm. The crewmember selects torque by setting the clutch ring. Forward or reverse rotation is selected by setting the tighten/loosen switch. The tool has fixed speeds of 20 and 60 rpm which are controlled by a switch on the side of the tool opposite the tighten/loosen switch. The motor is engaged by pulling back on the trigger-style control switch in the handle. Releasing the control switch disengages the motor. The tool direction switch should be returned to the OFF position when it is not in use. The tool uses a replaceable/rechargeable 7.2 volts dc nickel-cadmium battery pack. The battery pack life is dependent on the duration and loads that it will see. The EVA power tool and its battery packs are usually stored in a middeck locker for launch. The tool can be stored in the payload bay in a tool container, but without the battery packs.

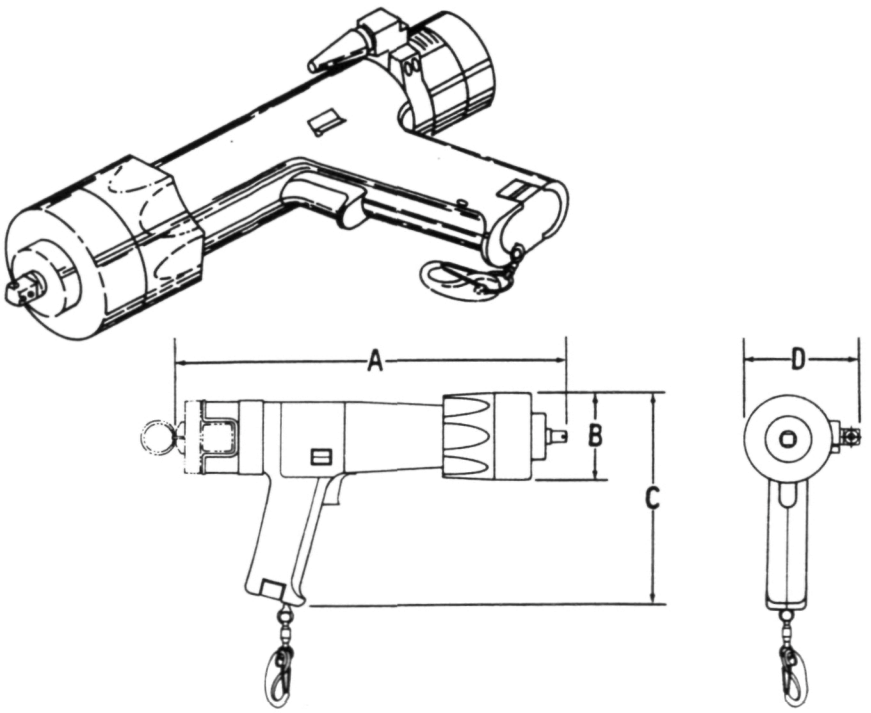
CONTACTS

Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

POWER TOOL, EVA (HST)

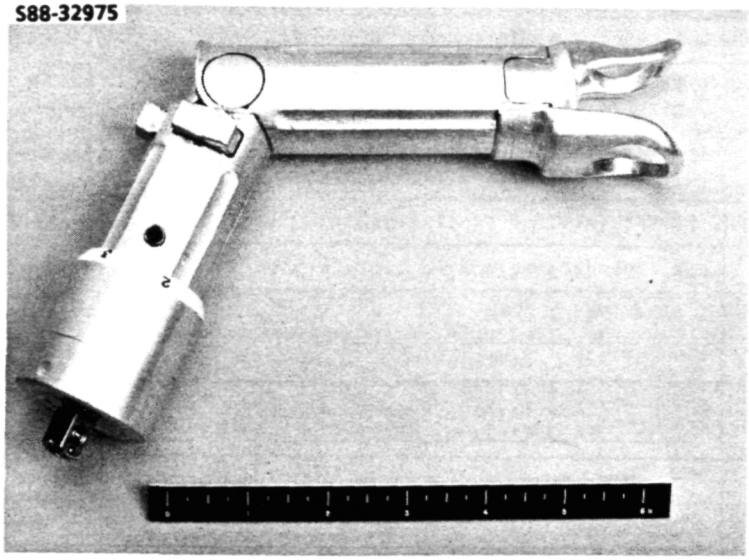
Technical Information	
Part number	10181-10001-01 without Velcro 10181-10001-02 with Velcro
Weight	3.40 lb (without battery)
Material/ construction	Body: Glass-filled Lexan Reflective aluminum tape
Temperature range	-150° to +250° F
Lubricants used	Fluorinated polyester Vacuumized grease
Power source	7.2 V rechargeable Ni-Cd battery pack
Speed	20 rpm, 60 rpm (with low torque loads)
Stall torque values (in-lb)	Low speed: Position 1 — Tighten/Loosen 48; 2 — 85; 3 — 128; 4 — 160 High speed: Position 1 — 29; 2 — 66; 3 — 177; 4 — 298
No. fasteners per battery charge	48 - LO speed, no. 8 screws, 1/2-inch length, fine threads 44 - HI speed, 1/4-inch screws, 1/2-inch length, fine threads
Availability	Flight specific

Dimensional Data	
A	12.20 in.
B	2.75 in.
C	6.70 in.
D	3.63 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

POWER TOOL, MINI



OVERVIEW

The mini power tool is a battery-operated screwdriver intended for use when a larger power tool is not required and when work space is limited. The tool can be used as a power tool or, with the power off, the output shaft is locked automatically for use as a manual driver. The design includes a 3/8-inch drive drop-proof tether fitting, forward and reverse drive rotation, six clutch settings from 1 to 14 in-lb, and tether points on the removable battery pack and the tool handle.

OPERATIONAL COMMENTS

After one of the six clutch settings has been selected, the crewmember depresses a thumb lever switch to initiate forward or reverse rotation. Releasing the control switch disengages the motor. The tool has a single no-load speed (forward or reverse) of 170 rpm. It incorporates a replaceable/rechargeable 2.4 V dc, 1.7 A-hr nickel-cadmium battery pack with a 30-amp fuse.

The drive locks when the power is off, allowing the tool to be used as a manual driver. The maximum locking torque for manual tightening is 135 in-lb. The housing is hinged to allow 65° articulation, which gives a mechanical advantage in manual tightening.

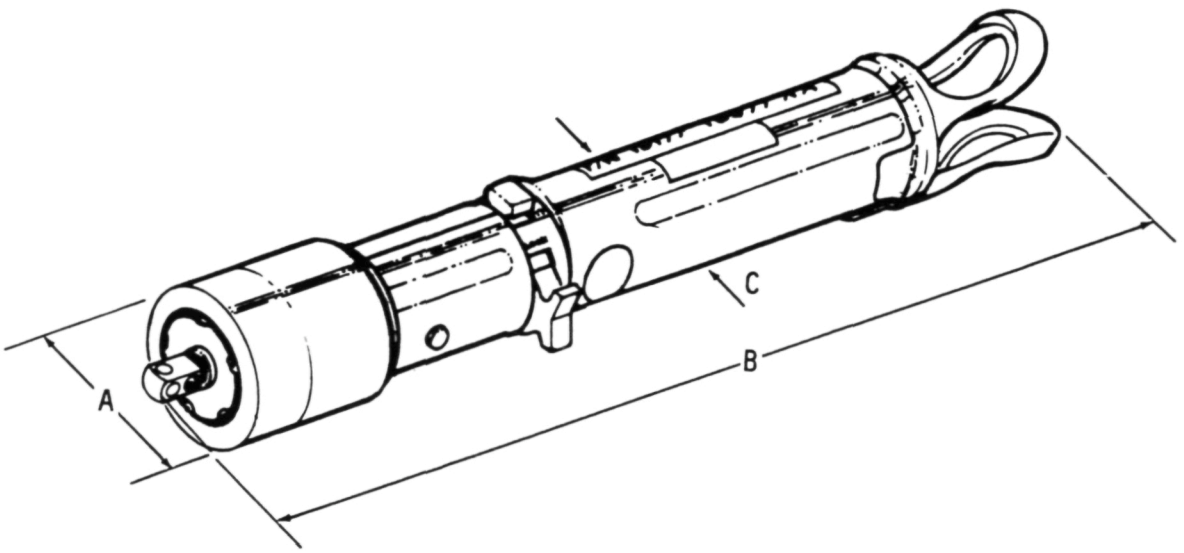
CONTACTS

Operational: R.C. Trevino, NASA/DF42, (713) 483-2597
Technical: R.J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

POWER TOOL, MINI

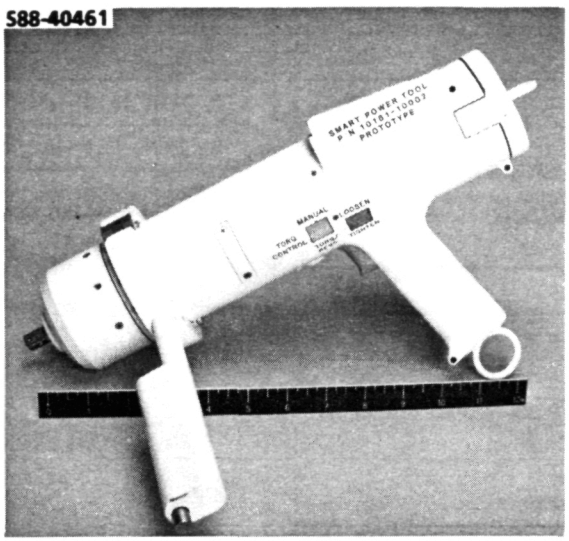
Technical Information	
Part number	10181-10036-01
Weight	1.03 lb With the battery pack 0.28 lb Battery only
Material/ construction	Housing - ABS cycolac reflective aluminum tape
Temperature range	-130° to +150° F (operational)
Power source	2.4 V rechargeable NiCd battery pack
Clutch settings	1 1.0 in-lb 2 1.5 in-lb 3 2.0 in-lb 4 2.4 in-lb 5 4.4 in-lb 6 14.0 in-lb
Availability	Flight specific

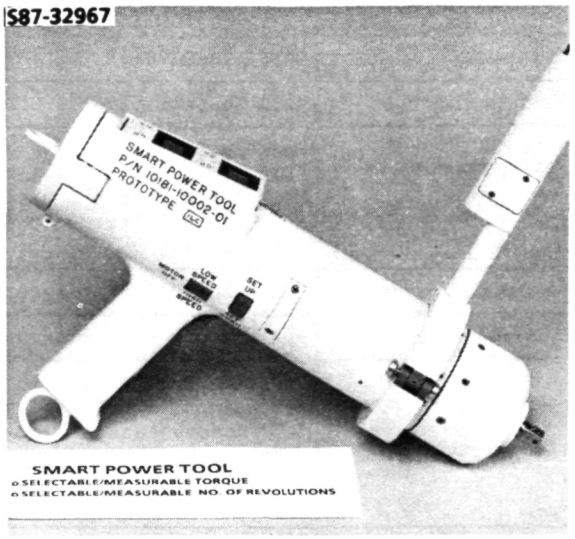
Dimensional Data	
A	1.77 in.
B	10.95 in.
C	1.42 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

POWER TOOL, SMART





OVERVIEW

The smart power tool is a hand-held, battery-powered, microprocessor-controlled device with regulated torque and revolution. It has a 3/8-inch drive drop-proof tether fitting for attaching sockets, screwdrivers, drill bits, and similar items. User interface includes two digital displays for set and actual values, a hi-lo speed switch, a forward-reverse switch, a manual torque/torque only/revolution switch, and an up-down set switch. Power is provided by a 7.2-volt rechargeable battery pack which plugs into the back end of the tool. This tool is in development.

OPERATIONAL COMMENTS

The smart power tool can be used for any EVA task that requires the precisely regulated outputs of torque, revolutions, or a combination of the two. The parameters are keyed in by the user and then electronically regulated by the tool. Torque can be set from 5 to 180 in-lb and revolutions from 0.5 to 125. Two speeds are available, high at 60 rpm and low at 20 rpm. The tool is operated much like a cordless drill via a pistol grip and trigger arrangement. A torque reaction arm that attaches near the front of the tool is also in development.

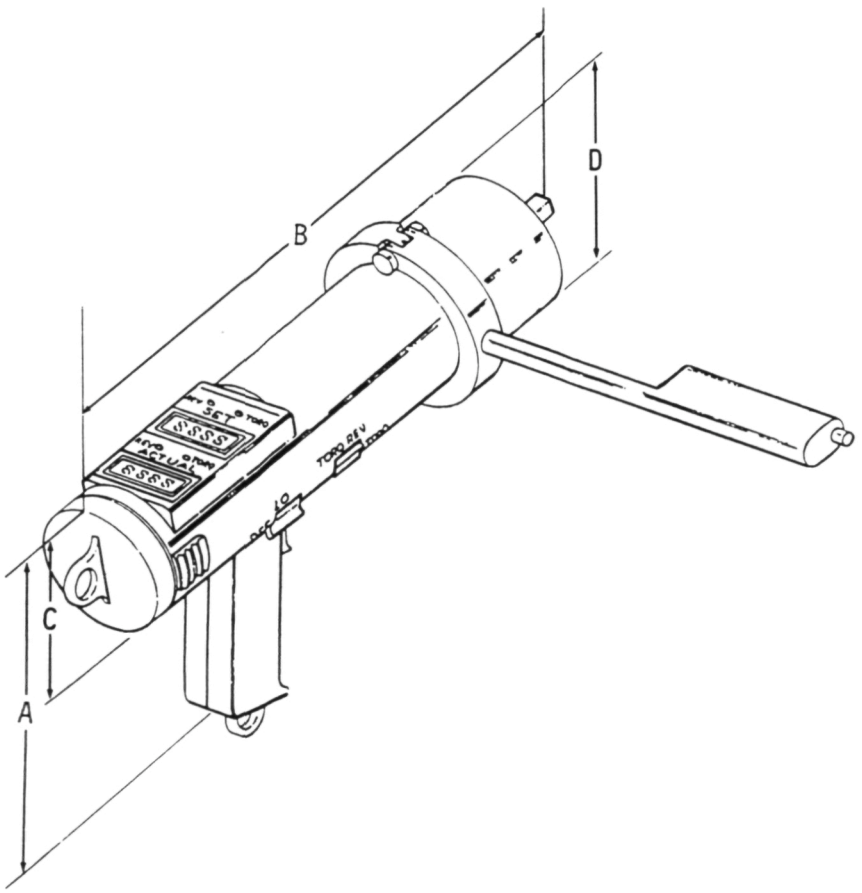
CONTACTS

Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

POWER TOOL, SMART

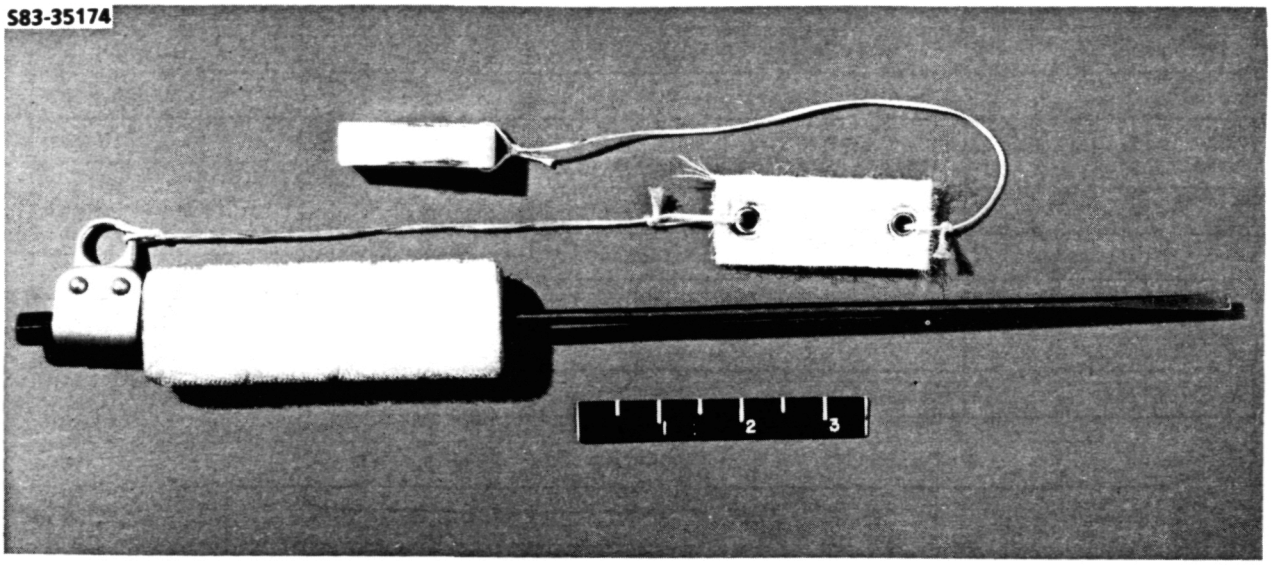
Technical Information	
Part number	10181-10002-01
Weight	12.0 lb (estimate)
Material/ construction	Housing - aluminum Gears - copper and stainless steel Magnetic particle brake/clutch Solid state electronic circuitry NiCd battery
Temperature range	-150° to +250° F (operational)
Power source	7.2 V dc rechargeable battery pack
Settings	Torque - 5 to 180 in-lb (1 in-lb increments) Revolutions - 0.5 through 125 (0.5 rev increments) Speed - LO 20 rpm HI 60 rpm Direction - forward and reverse
Availability	Developmental

Dimensional Data	
A	6.5 in.
B	14.5 in.
C	2.5 in.
D	2.0 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

PROBE



OVERVIEW

The probe is a 0.188-inch diameter rod with a flattened screwdriver-type tip. Made of tool steel with a Velcro-wrapped aluminum handle, the 14.5-inch probe has a ring for tether attachment and a Teflon protective cap for the tip.

OPERATIONAL COMMENTS

The tool is used for probing jammed equipment, loosening, and determining bolt-hole alignment. It is part of the normally manifested STS equipment and is wrapped in a Velcro-lined tool caddy along with the hammer and stowed in the starboard provisions stowage assembly (PSA).

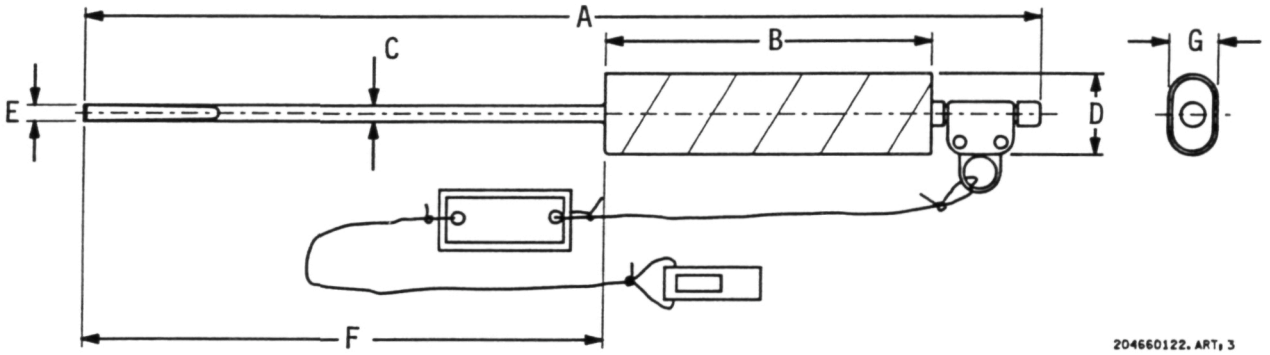
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: J. Madden, Rockwell/Houston, (713) 282-5300

PROBE

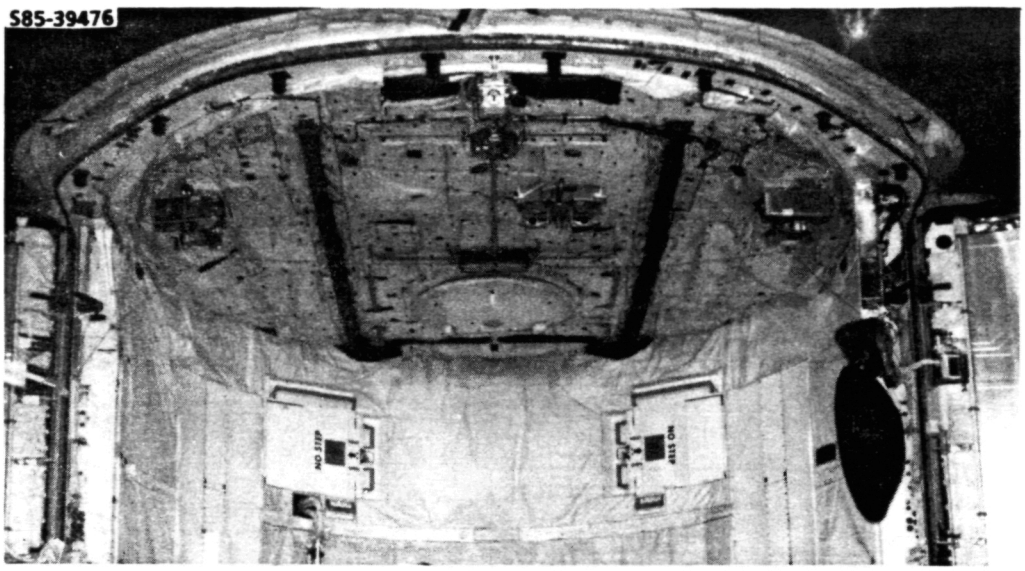
Technical Information	
Part number	V628-650879-005 or SDD33103434-301
Weight	0.6 lb
Material/ construction	Rod - tool steel Handle - aluminum, Velcro-wrapped, tether ring
Rod diameter	0.188 in.
Temperature range	-200° to 250° F (operational)
Quantity flown	One in starboard PSA
Availability	Standard

Dimensional Data	
A	11.0000 in.
B	4.0000 in.
C	0.1880 in.
D	1.2500 in.
E	0.1875 in.
F	8.7500 in.
G	0.7500 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

PROVISIONS STOWAGE ASSEMBLY



OVERVIEW

The provisions stowage assembly (PSA) is a container mounted under the cargo bay liner area for stowage of tools and equipment. Both the port and starboard sides of the Orbiter fuselage have one container. The PSA is built from aluminum sheet metal and machined parts. The PSA will stow various tools and equipment necessary to support Orbiter EVA contingency tasks as well as those for specific EVA missions. Most of the tools are wrapped in tool caddies or tool bags and stowed in designated compartments. The compartments are custom cut foam lined with fabric. Tool caddies are friction fitted in place with tether rings visible. The PSA has handrails located on three sides.

OPERATIONAL COMMENTS

The PSA door has a pivoting handle coupled with a positive locking device which latches the cover in its closed position. The maximum force required to overcome the open or close position pawl spring load is less than 25 pounds. The metal door slides open to expose the compartmentalized PSA liner, which stores the EVA equipment. The lower portion of the door is hinged and held open by a spring-loaded roller. A decal diagram located on the door cover shows the positions of the tools stowed in the container. A limited amount of space remains in the PSA for future tools.

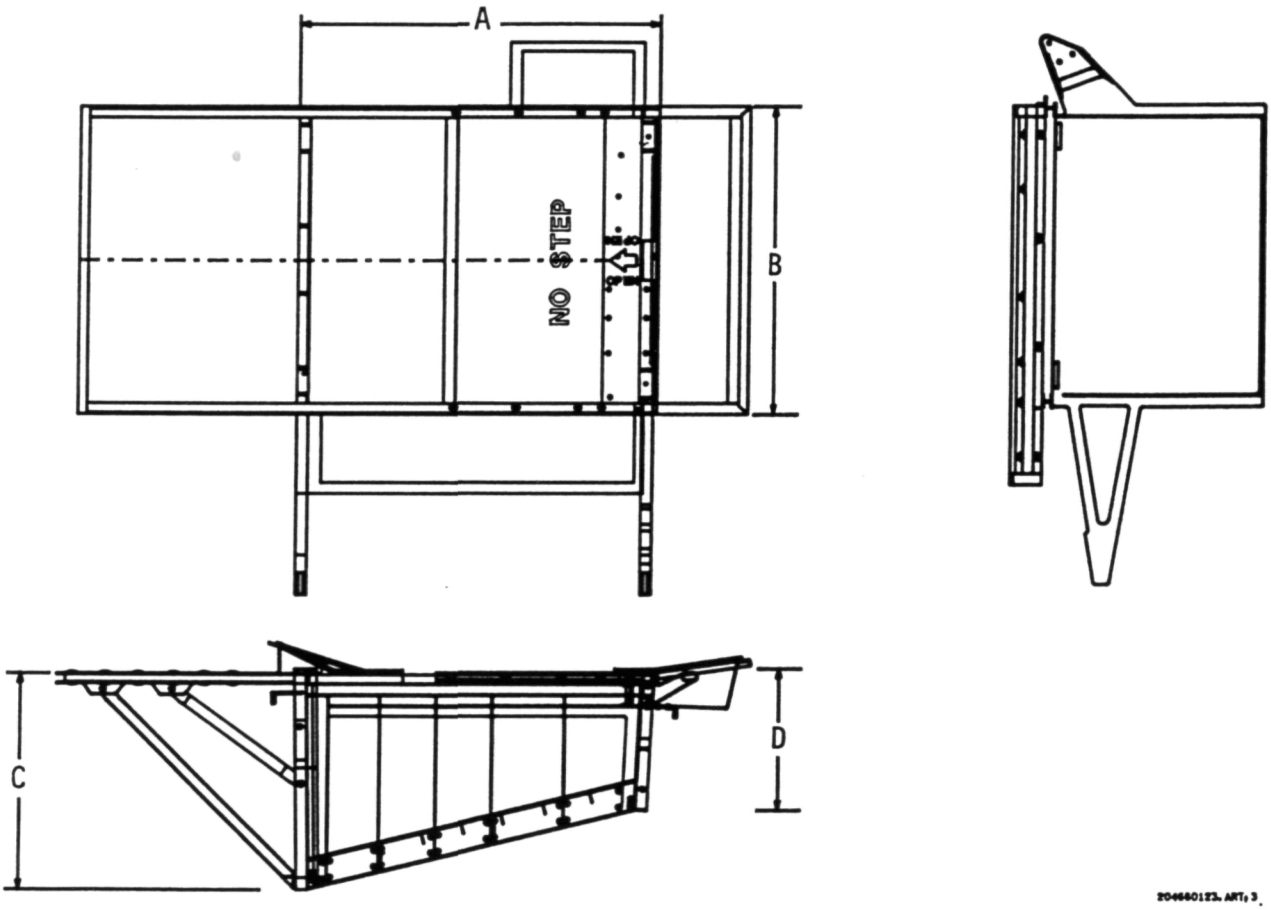
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: J. Madden, Rockwell/Houston, (713) 282-5300

PROVISIONS STOWAGE ASSEMBLY

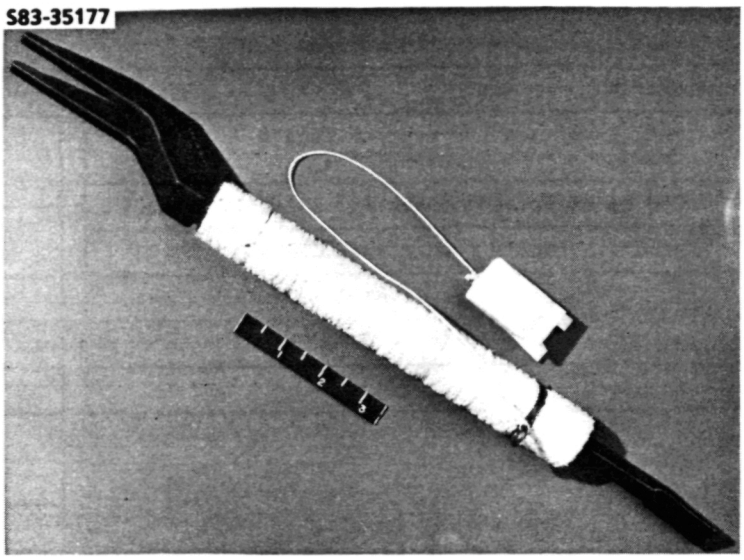
Technical Information	
Part number	V568-340428
Weight	54.0 lb (empty)
Material	Aluminum sheet metal
Temperature range	-200° to 350° F
Quantity flown	Two, port and starboard
Availability	Standard

Dimensional Data	
A	31.5 in.
B	27.5 in.
C	17.0 in. (port) 20.0 in. (stbd)
D	10.0 in. (stbd) 12.0 in. (port)



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

PRY BAR



OVERVIEW

The pry bar has a 1/2-inch slot on one end and a blunt chisel on the other end. The slotted end is 3-7/8 inches long, and the chisel end is 3-3/8 inches long. The handle may be extended 4-1/2 inches for extra leverage. The bar itself is partially wrapped with Velcro for tool caddy stowage and has a tether ring to prevent loss of the tool during EVA. A Teflon protective cap on a lanyard protects against inadvertent punctures.

OPERATIONAL COMMENTS

The pry bar is a general purpose jam removal tool with no specific tasks designated. It is part of the normally manifested STS equipment. It is wrapped in a Velcro-lined tool caddy along with the forceps and is stowed in the starboard provisions stowage assembly (PSA).

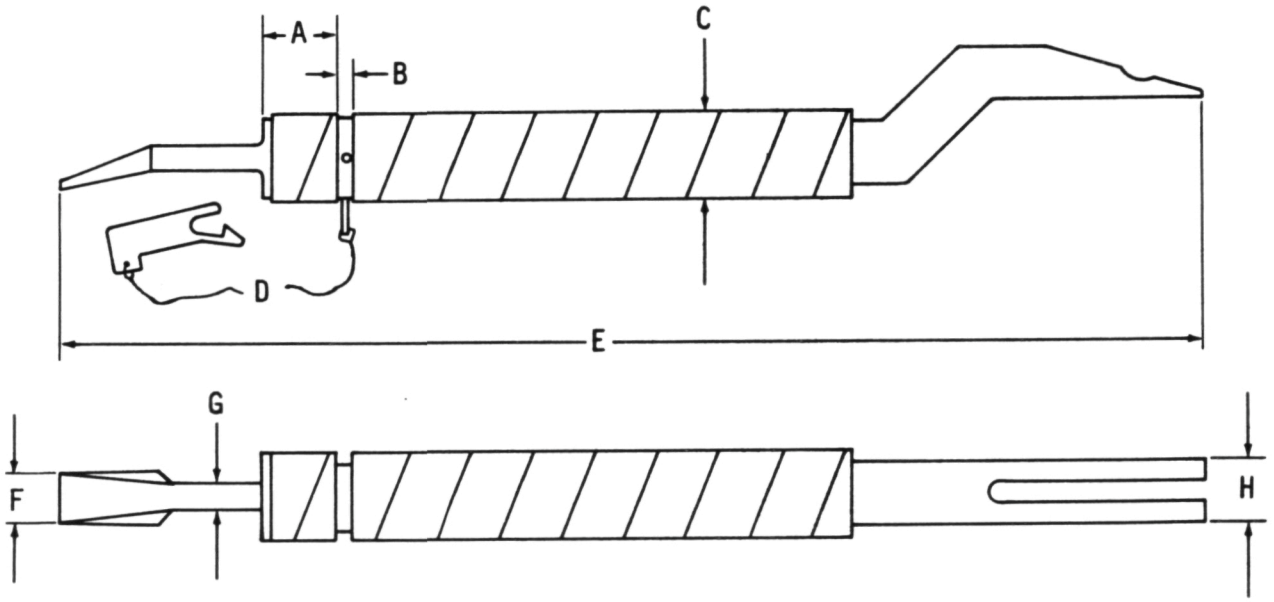
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: J. Madden, Rockwell/Houston, (713) 282-5300

PRY BAR

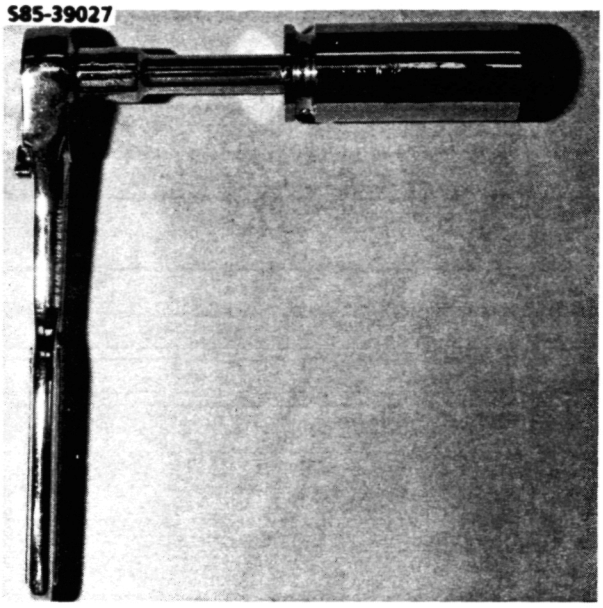
Technical Information	
Part number	V628-650990-006 or SDD33103444-301
Weight	3.2 lb
Material/ construction	Tool steel, Velcro-wrapped handle Lubricant - Molylrote 321R
Handle	Can be extended 4.5 in. for extra leverage
Temperature range	-200° to 250° F (operational)
Quantity flown	One stored in starboard PSA
Availability	Standard

Dimensional Data	
A	1.12 in.
B	0.25 in.
C	1.24 in.
D	12.00 in.
E	17.40 in. min 21.90 in. max.
F	0.60 in.
G	0.40 in.
H	1.00 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

RATCHET WITH 15/16-INCH HEX SOCKET



OVERVIEW

The ratchet with 15/16-inch hex socket is a combination of common tools modified for EVA use. It is comprised of a 3/8-inch drive ratchet, an extension, and a 15/16-inch, 12-point deep socket. The socket is pinned to the extension, which is pinned to the ratchet.

OPERATIONAL COMMENTS

The ratchet with 15/16-inch hex socket is a disconnect tool used in a contingency situation to remove the remote engagement mechanism (REM) to mission-peculiar equipment support subsystem (MPESS) bolts. The ratchet can be used with any 15/16-inch hex bolts or nuts.

CONTACTS

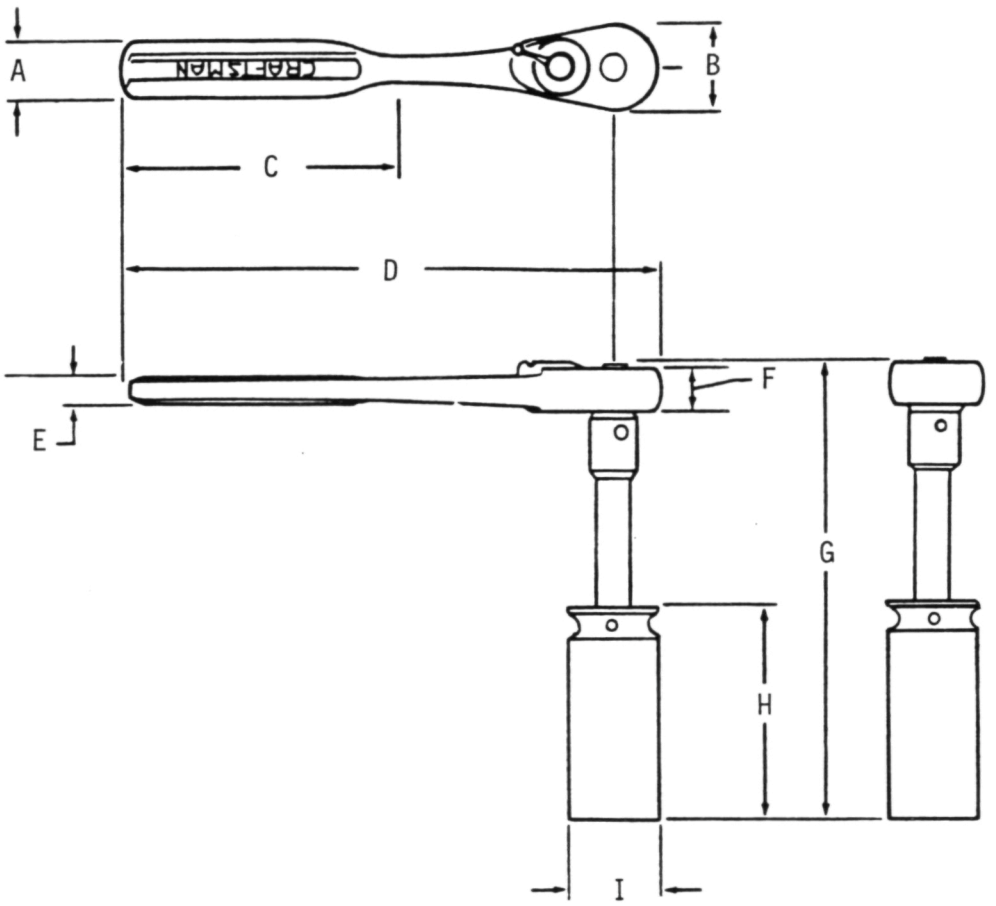
Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: R. Scott, NASA/GSFC, (301) 286-2210
Source: R. Scott, NASA/GSFC, (301) 286-2210

Section
PAGE 2 INTENTIONALLY BLANK
PRECEDING PAGE BLANK NOT FILMED

RATCHET WITH 15/16-INCH HEX SOCKET

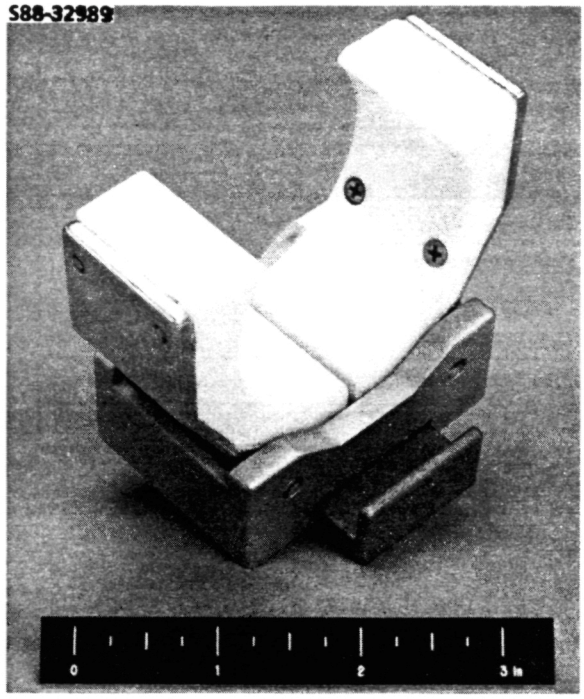
Technical Information	
Part number	GC 38169
Weight	1.1 lb
Material	Nickle-plated stainless steel
Force/torque	100 in-lb
Design temperature range	-130° to 150° F
Availability	Flight specific

Dimensional Data	
A	0.760 in.
B	1.156 in.
C	3.430 in.
D	6.750 in.
E	0.380 in.
F	0.600 in.
G	5.900 in.
H	2.760 in.
I	1.180 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

RETAINING MECHANISM, TOOL



OVERVIEW

The tool retaining mechanism is designed to be a universal tool clamp and can easily be modified to accommodate various tool configurations. Securing or removing a tool from the clamp does not require a large force since the design does not rely on the resiliency of the clamp material for retention. The tool incorporates a positive lock when in the closed position.

OPERATIONAL COMMENTS

This retaining mechanism does not function alone as a launch restraint. It is primarily intened for temporary restraint at a worksite. To secure a tool in the tool retaining mechanism, place the tool into the open clamp and push against its back edge. The spring-loaded jaws will automatically close and lock. To remove a tool, simply press the latch lever at the base of the clamp.

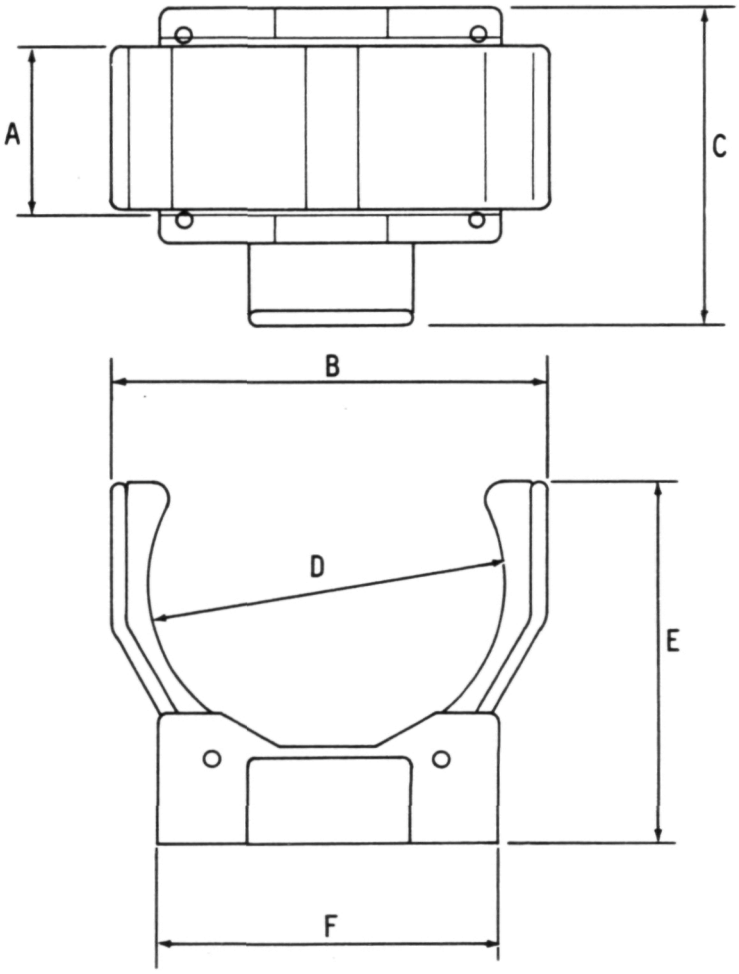
CONTACTS

Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

RETAINING MECHANISM, TOOL

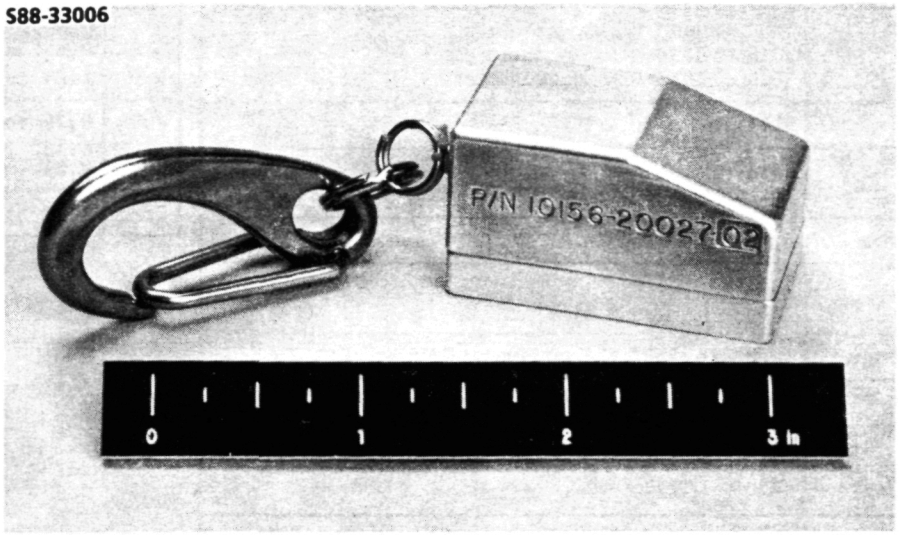
Technical Information	
Part number	10159-10054-01 10159-10054-02
Weight	1.05 lb
Material/ construction	Aluminum Teflon
Temperature range	-130° to 150° F (operational)
Internal diameter when closed	10159-10054-01 2.25 in. 10159-10054-02 2.75 in.
Availability	Developmental

Dimensional Data	
A	1.25 in.
B	3.38 in.
C	2.38 in.
D	2.25 in. (-01) 2.75 in. (-02)
E	3.94 in.
F	2.56 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

RETRACTABLE TETHER



OVERVIEW

Retractable tethers are used to restrain tools and small equipment stowed on tool boards and tool caddies for use during EVA. Tethers consist of a takeup reel enclosed in a housing, a 3-foot or 6-foot Kevlar tether line, and a swivel hook or hooks to secure tools and equipment. The 6-foot tether design incorporates a velocity limiting feature.

OPERATIONAL COMMENTS

The retractable tether extends and retracts smoothly, with no more than 0.25 pounds of retracting force. A french hook is sometimes fixed to the swivel hook to permit release of a tool from the retractable tether.

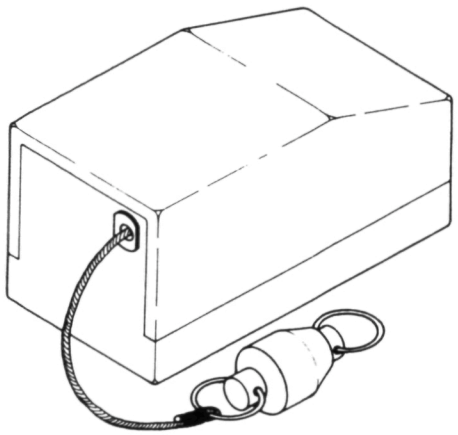
CONTACTS

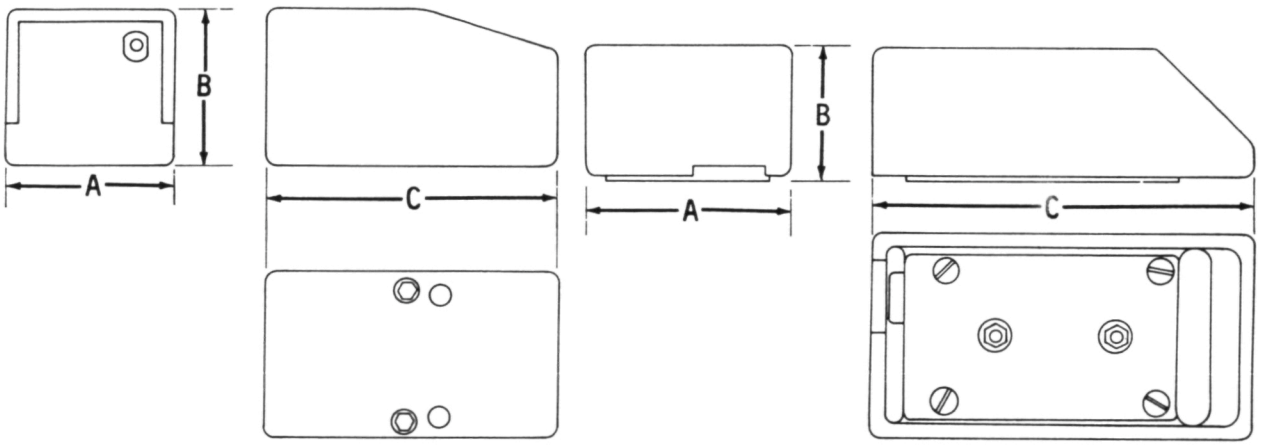
Operational: R. C. Trevino, NASA/DF4, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

RETRACTABLE TETHER

Technical Information	
Part number	10153-20004-01 Vespel case 10153-20004-02 aluminum case 10156-20027-02 aluminum case
Weight	0.14 lb
Material	Case - aluminum alloy or vespel Tether - 400 denier Kevlar cord
Retracting force	0.6 lb
Cord breaking strength	100 lb
Temperature range	-200° to 250° F (operational)
Quantity flown	Varies, used on tool caddies or tool boards
Stowage	Assembly dependent
Availability	Flight specific

Dimensional Data		
	10153-	10156-
A	1.24 in.	1.00 in.
B	0.79 in.	0.97 in.
C	2.31 in.	1.76 in.
Cord	3.00 ft.	6.00 ft.



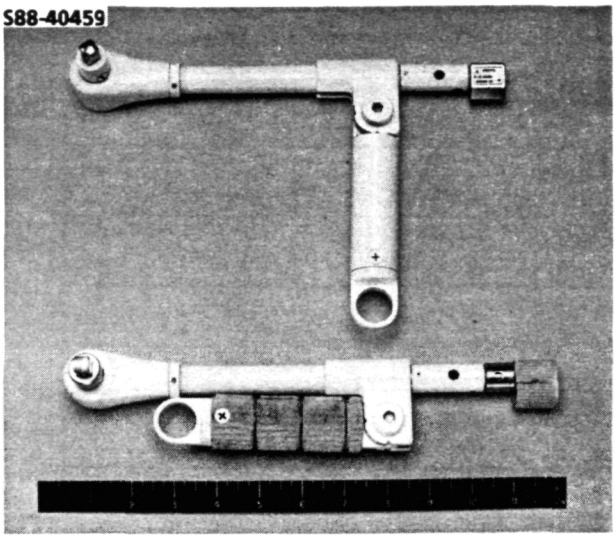


10156-20027-02

10153-20004-01/02

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

RIGHT ANGLE DRIVE



OVERVIEW

The right angle drive transmits torque 90° to various driver tips. It is normally used with the EVA power tool.

OPERATIONAL COMMENTS

The right angle drive tool has a 3/8-inch square drive and accepts driver or drill tips fitted with drop-proof tether interfaces. Each version of the tool has a folding handle on the right side and drop-proof tether interfaces: male at the output end and female at the input end. 10176-20150-01 has a Velcro-wrapped handle and drop-proof tether. It was flown and successfully used on STS 51-I to aid in access to a cover plate under the Syncom IV UHF receiver antenna. 10181-10048-01 uses no Velcro and has a lightweight mini drop-proof tether. It has been designed for use during maintenance of the Hubble Space Telescope (HST).

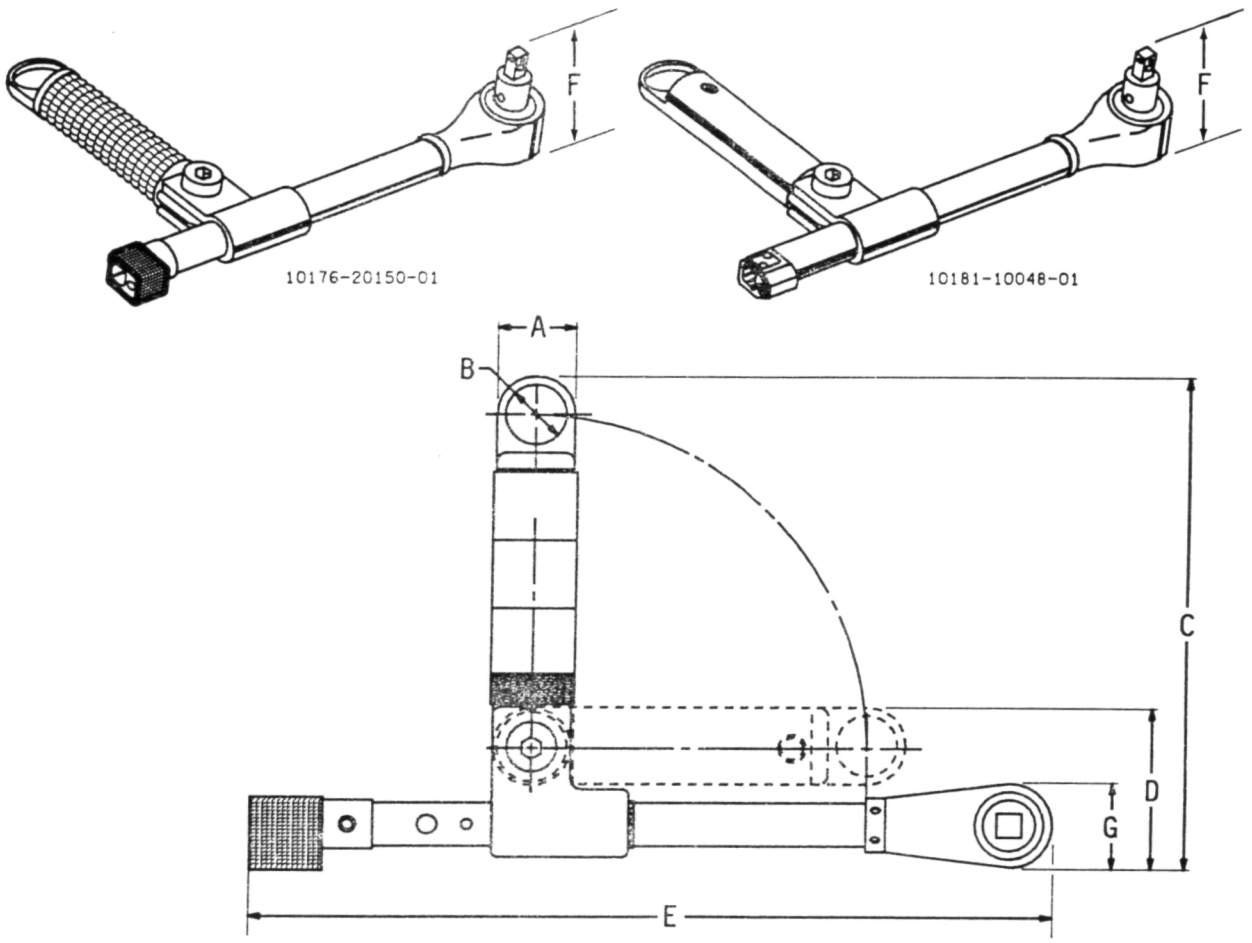
CONTACTS

Operational: R. C. Trevino, NASA/DF4, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

RIGHT ANGLE DRIVE

Technical Information	
Part number	10176-20150-01 or 10181-10048-01
Weight	2.0 lb
Material	Stainless steel, alumin...
Force required to release	10 lb maximum
Tolerances	Force of 20 lb Torque of 200 in-lb
Quantity flown	One on STS 51-I (10176-20150-01)
Stowage	Shuttle cabin for STS 51-I
Availability	Flight specific

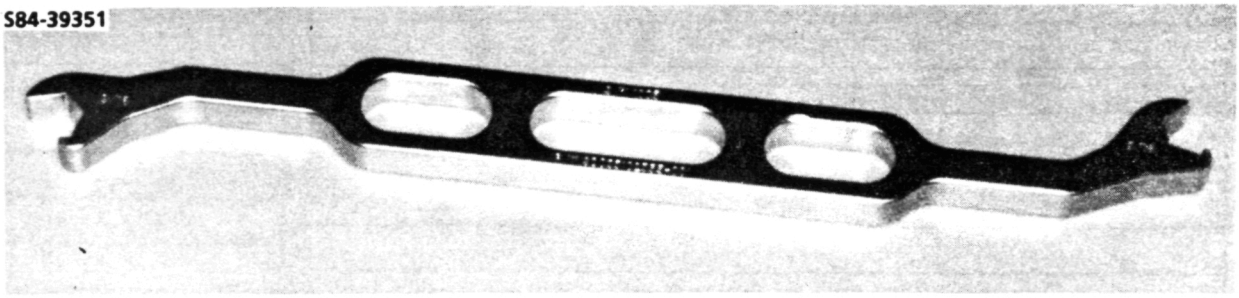
Dimensional Data	
A	1.18 in.
B	0.90 in.
C	7.22 in.
D	2.34 in.
E	11.62 in. (10176) 10.83 in. (10181)
F	2.44 in.
G	1.25 in.



204660167.ART; 2

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

RMS MPM WRENCH



OVERVIEW

The remote manipulator system (RMS) manipulator positioning mechanism (MPM) wrench is a double-ended open-end wrench, with the ends of the wrench angled 30° off center. (One end is 30° up; the other is 30° down.) Both ends have 9/16-inch openings with a large upper jaw and a very small lower jaw, allowing ratcheting motion.

OPERATIONAL COMMENTS

The RMS MPM wrench is used in the event of MPM stow/deploy failure. It is used on a hex section of the MPM drive shaft. Turning the drive shaft rolls the MPM's back into the stowed position, thus allowing the payload bay doors to close. This tool is part of the normally manifested STS equipment and is stowed in the port provisions stowage assembly (PSA).

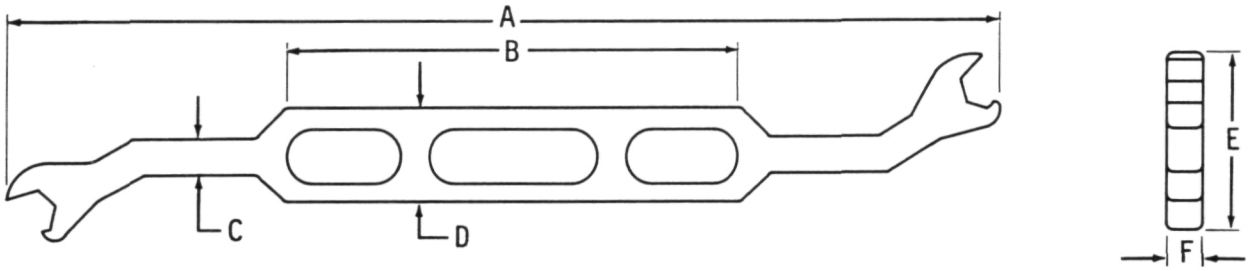
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: T. Ross, NASA/ES6, (713) 483-8941
Source: T. Ross, NASA/ES6, (713) 483-8941

RMS MPM WRENCH

Technical Information	
Part number	SDD33102355-001
Weight	1.25 lb
Material/ construction	#496 oil-hardened flat stock steel with an electroless nickle plating
Quantity flown	One in the starboard PSA
Availability	Standard

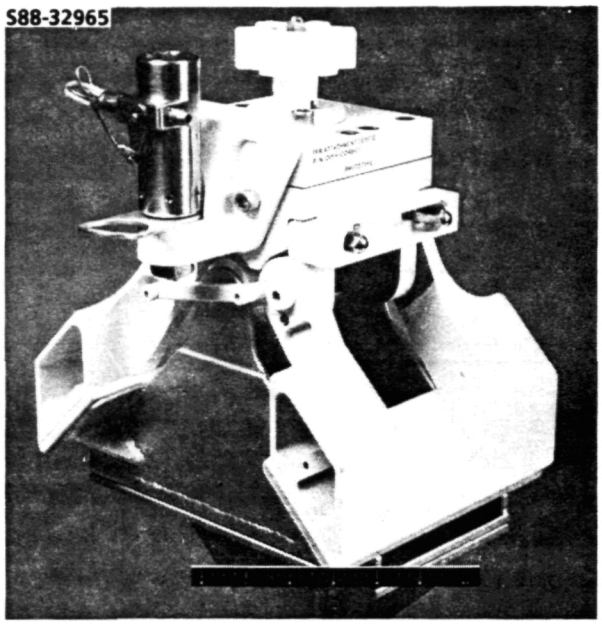
Dimensional Data	
A	13.60 in.
B	6.26 in.
C	0.50 in.
D	1.30 in.
E	2.44 in.
F	0.50 in.



204660128.ART,1

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

RMS PFR ATTACHMENT DEVICE



OVERVIEW

The portable foot restraint (PFR) attachment device is an adapter which allows a PFR to be attached to a striker bar of the remote manipulator system (RMS) manipulator retention latches. The striker bar nearest the RMS end effector provides a PFR configuration much like an MFR. The device is manually attached to the strike bar by the crewmember after the RMS has been removed from its berth. The PFR is attached to the device via a built-in PFR socket. The design allows the device's outrigger feet to be folded for minimum stowage envelope.

OPERATIONAL COMMENTS

After the PFR attachment device is unstowed, its outrigger feet are unfolded. The device is unlocked by rotating the knob counterclockwise approximately 45°, and soft-dock is selected by further rotation of the knob. The device is soft-docked onto the striker bar and secured by rotating the knob clockwise. The knob's locking feature is actuated to prevent inadvertent backout. The stem of the PFR is then secured into the built-in PFR socket.

Removal of the PFR attachment device is required to allow stowage of the RMS. The knob is unlocked and rotated to the open position to allow removal of the device.

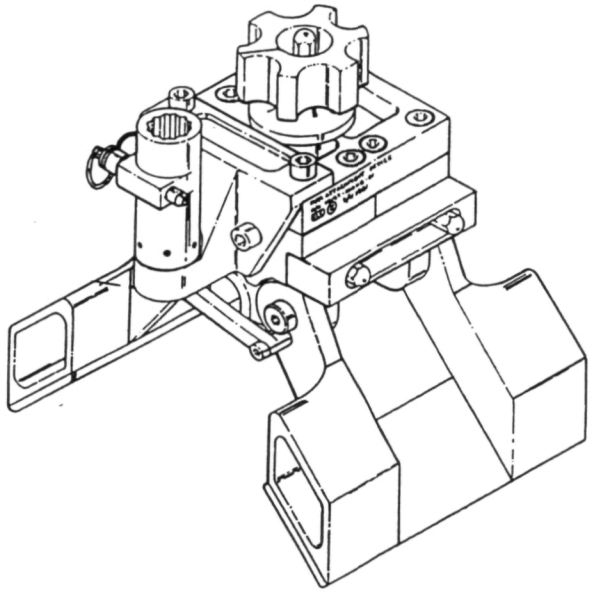
CONTACTS

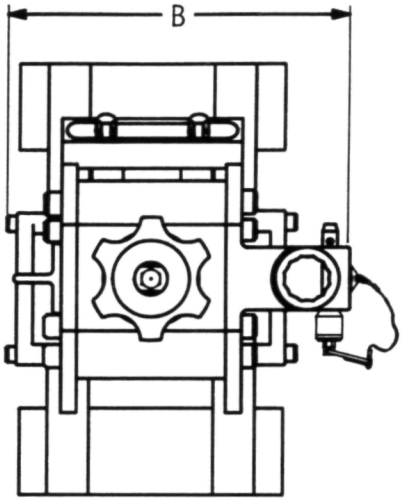
Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

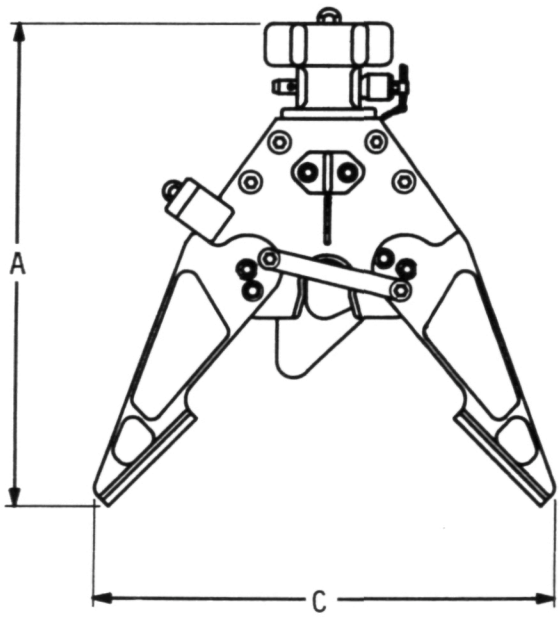
RMS PFR ATTACHMENT DEVICE

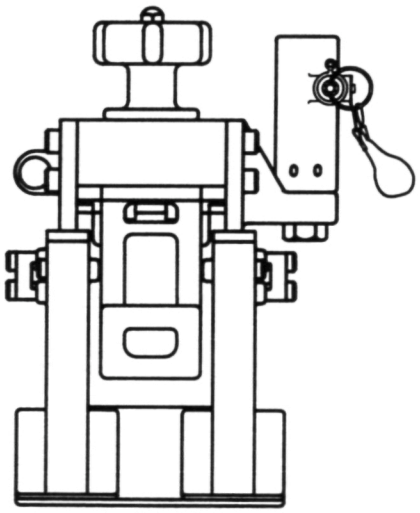
Technical Information	
Part number	10159-10053-01
Weight	10.5 lb (est)
Material/ construction	Stainless steel Aluminum
Temperature range	-130° to +150° F (operational)
Availability	Developmental

Dimensional Data	
A	11.60 in.
B	8.24 in.
C	7.50 in. stowed 10.34 in. max. open





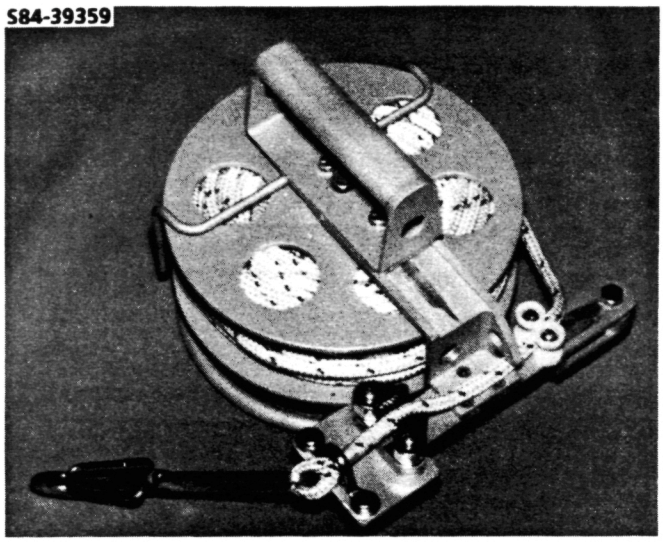




204660171.ART, 2

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

RMS ROPE REEL



OVERVIEW

The remote manipulator system (RMS) rope reel is comprised of a rope spool with handle, spool bracket, rope guide and rollers, and cam cleats. The RMS rope reel holds 80 feet of 5/16-inch-diameter rope. The rope has a 7-3/4-inch hook on the end, with a spring clip for positive attachments.

OPERATIONAL COMMENTS

The RMS rope reel is used in conjunction with the snatch blocks in the event of RMS joint failure. The rope is routed through the snatch blocks and attached to the handrail on the tip of the RMS. The crewmember then back-drives the RMS into the stowed position using the RMS rope reel. The spool bracket and the rope spool both have handles. The rope reel has two cam cleats which clamp down on the rope to prevent it from being pulled off the reel. To achieve maximum loading of the rope reel, the rope must be routed around both cleats. Up to a 0.78-inch-diameter cross section will be accepted by the hook. This tool is part of the normally manifested STS equipment and is stowed in the port provision stowage assembly (PSA).

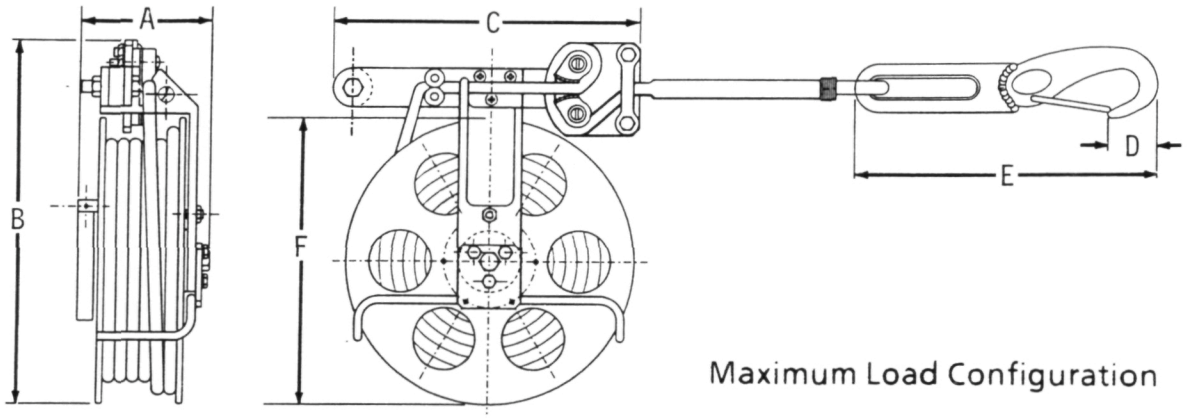
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: T. Ross, NASA/ES6, (713) 483-8941
Source: T. Ross, NASA/ES6, (713) 483-8941

RMS ROPE REEL

Technical Information	
Part number	SED33102348-303
Weight	8.00 lb
Material	Spool and spool bracket - aluminum Rope guides, cam cleats, and hook - tool steel Rope - 80 ft 5/16-in. diameter (Kevlar inner cord, Kexlon outer wrap)
Temperature range	-200° to 250° F (operational)
Load limit	725 lb (nominal) 840 lb (proof)
Quantity flown	One in the port PSA
Availability	Standard

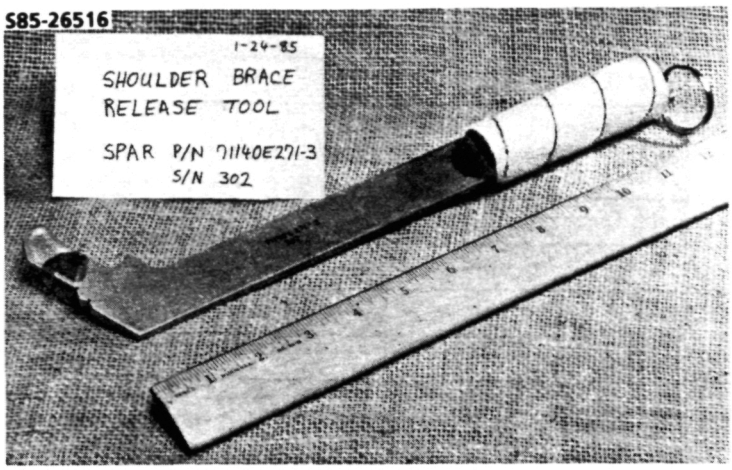
Dimensional Data	
A	4.250 in.
B	11.800 in.
C	9.875 in.
D	1.250 in.
E	7.750 in.
F	9.250 in.



Maximum Load Configuration

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

RMS SHOULDER BRACE RELEASE TOOL



OVERVIEW

The remote manipulator system (RMS) shoulder brace release tool is a flat bar with an angled foot tip. It has a built-up handle covered with Velcro for a positive grip. A tether ring has been added for tether attachment.

OPERATIONAL COMMENTS

The RMS shoulder brace release tool is a disconnect tool used in the event of failure of the RMS shoulder brace release motor. The shoulder brace must be removed before the RMS can be used. The RMS shoulder brace release tool is used to push up a retaining bracket, thus releasing the shoulder brace. This tool is part of the normally manifested STS equipment and is stowed in the port provisions stowage assembly (PSA).

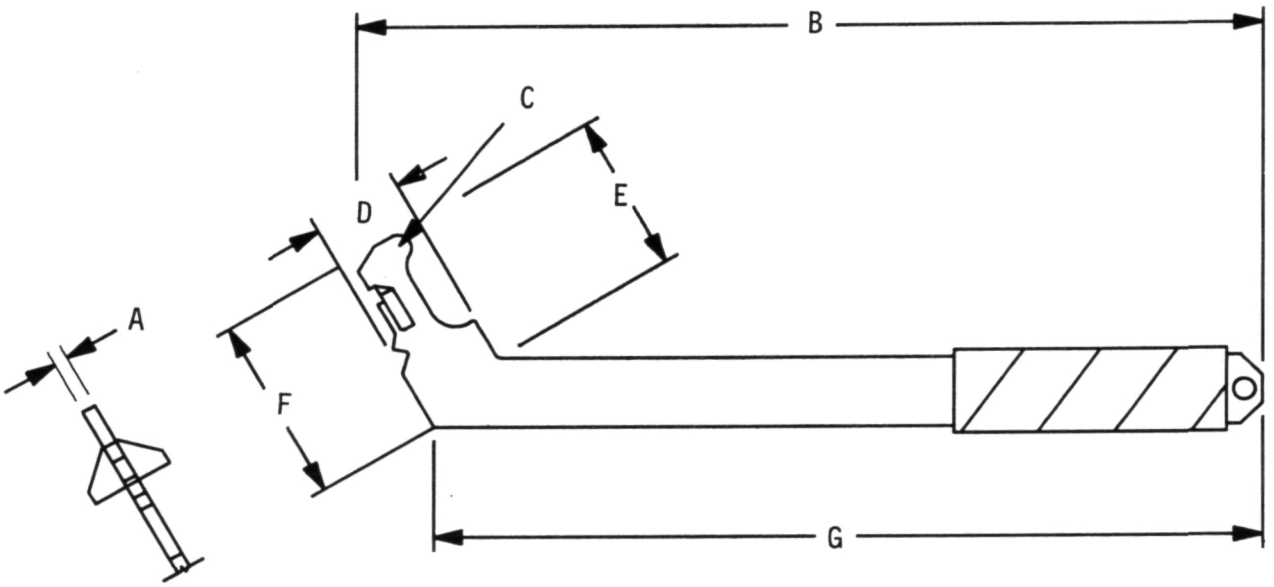
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: T. Ross, NASA/ES6, (713) 483-8941
Source: T. Ross, NASA/ES6, (713) 483-8941

RMS SHOULDER BRACE RELEASE TOOL

Technical Information	
Part number	71140E271-3
Weight	1.1875 lb
Material	Tool blade - 304 steel Guide attachment - 304 steel Handle - aluminum
Quantity flown	One in the port PSA
Availability	Standard

Dimensional Data	
A	0.23 in.
B	13.00 in.
C	0.22 in.
D	1.12 in.
E	2.28 in.
F	2.69 in.
G	12.00 in.

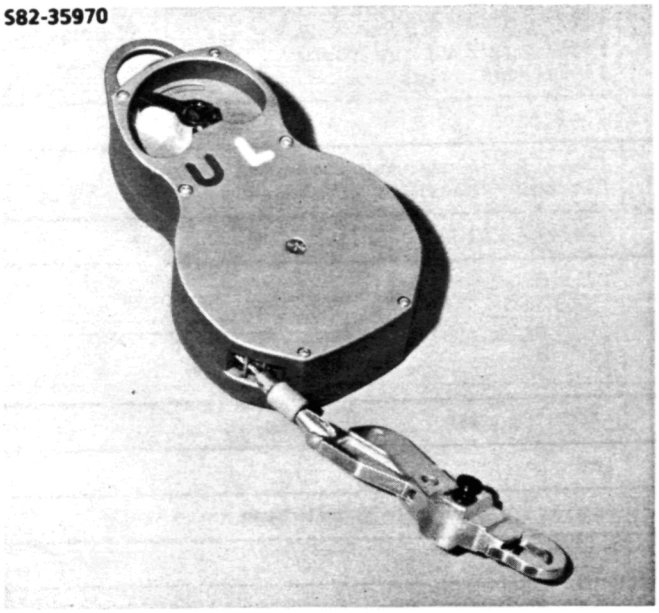


204660130.ART;2

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

SAFETY TETHER

S82-35970



OVERVIEW

The safety tether connects the crewmember to a slide wire along the cargo bay sill longeron during EVA. The tether consists of a reel case with an integral D-ring, a takeup reel, a 35-foot cable, and a locking hook. A selector on the reel case can be used to engage or disengage the auto retracting feature of the tether reel.

The locking hook on the tether incorporates a lock-lock feature to prevent accidental opening.

OPERATIONAL COMMENTS

For launch and entry, the port and starboard safety tethers are stowed in a cloth-covered stowage container which is secured to the bulkhead above the airlock in the cargo bay. While still in the airlock, after opening the airlock hatch, a crewmember attaches a waist tether to the D-ring of the safety tether. The other end of the waist tether is hooked to a D-ring on the extravehicular mobility unit (EMU) waist bearing. A series of four Velcro straps secure the safety tether cable from the slide wire to the airlock during launch and entry.

All current 35-foot cable lengths will soon be replaced with a 55-foot cable. This change will be effective for the Hubble Space Telescope (HST) deploy mission.

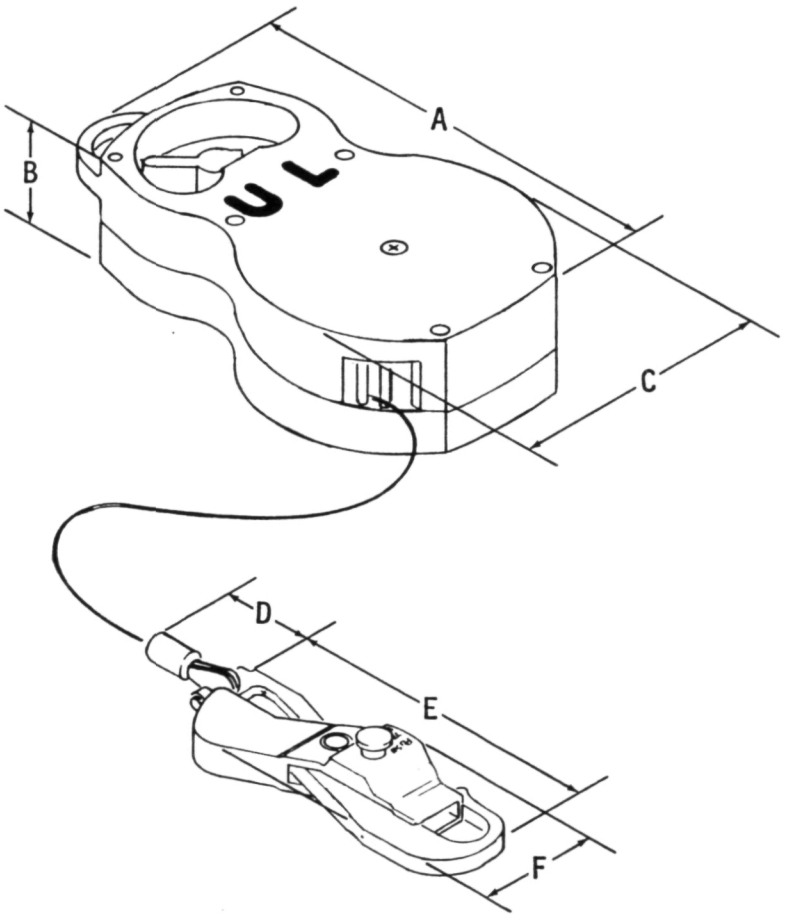
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: M. Withey, ILC Space Systems, (713) 488-9098

SAFETY TETHER

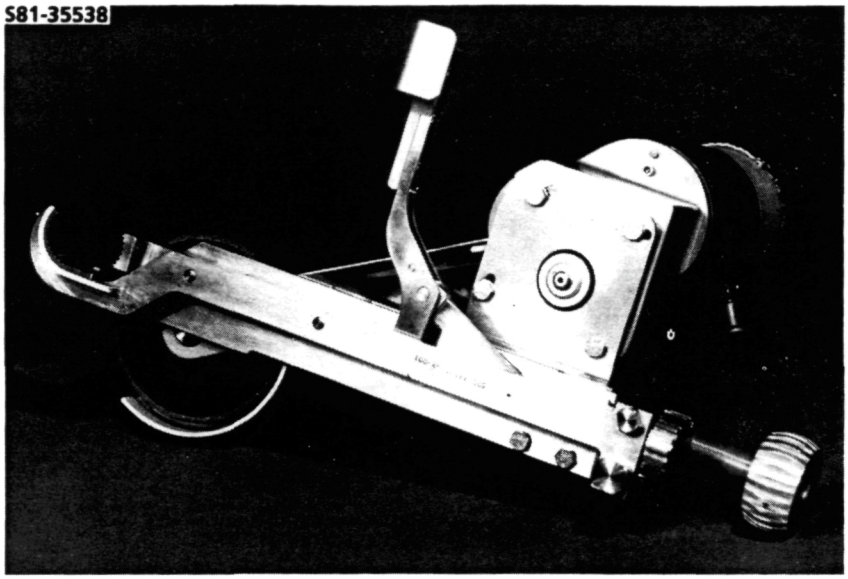
Technical Information	
Part number	10162-10062-04 (35-foot) 10162-10062-05 (55-foot) 9792 (hook only)
Weight	3.48 lb
Material	Housing - aluminum, stainless steel Tether - stainless steel cable, 3/32-in. dia
Load limit	Cable - 920 lb
Extension force (locked)	1.5 lb
Retraction force (unlocked)	0.5 lb
Temperature range	-200° to 250° F (operational)
Quantity flown	Two
Stowage	Payload bay X_o - 576 bulkhead
Availability	Standard

Dimensional Data	
A	8.360 in.
B	2.086 in.
C	4.490 in.
D	1.500 in.
E	5.000 in.
F	1.750 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

SAW



OVERVIEW

The saw is a circular hand-held power saw comprised of a frame, an electric motor, a blade housing, a depth-of-cut adjustment, a tube holder, and a load indicator. The saw will cut a tube or rod of up to 1.25 inches. It requires a 110-volt, 400-cycle ac external power source.

OPERATIONAL COMMENTS

The saw was designed to cut the actuation rods of the bulkhead latches in the event that they fail to close. They must be cut for a crewmember to backdrive the bulkhead latches to allow three-point latch tool attachment. The tube holder is used to hold the tube firmly against the blade. The depth of cut is controlled by turning a knob on the end of the frame. Built into the motor housing is a load indicator consisting of three lights: green, indicating very little load; yellow, indicating a normal load; and red, indicating an overload and possible stalling. This tool is currently in the final stages of development.

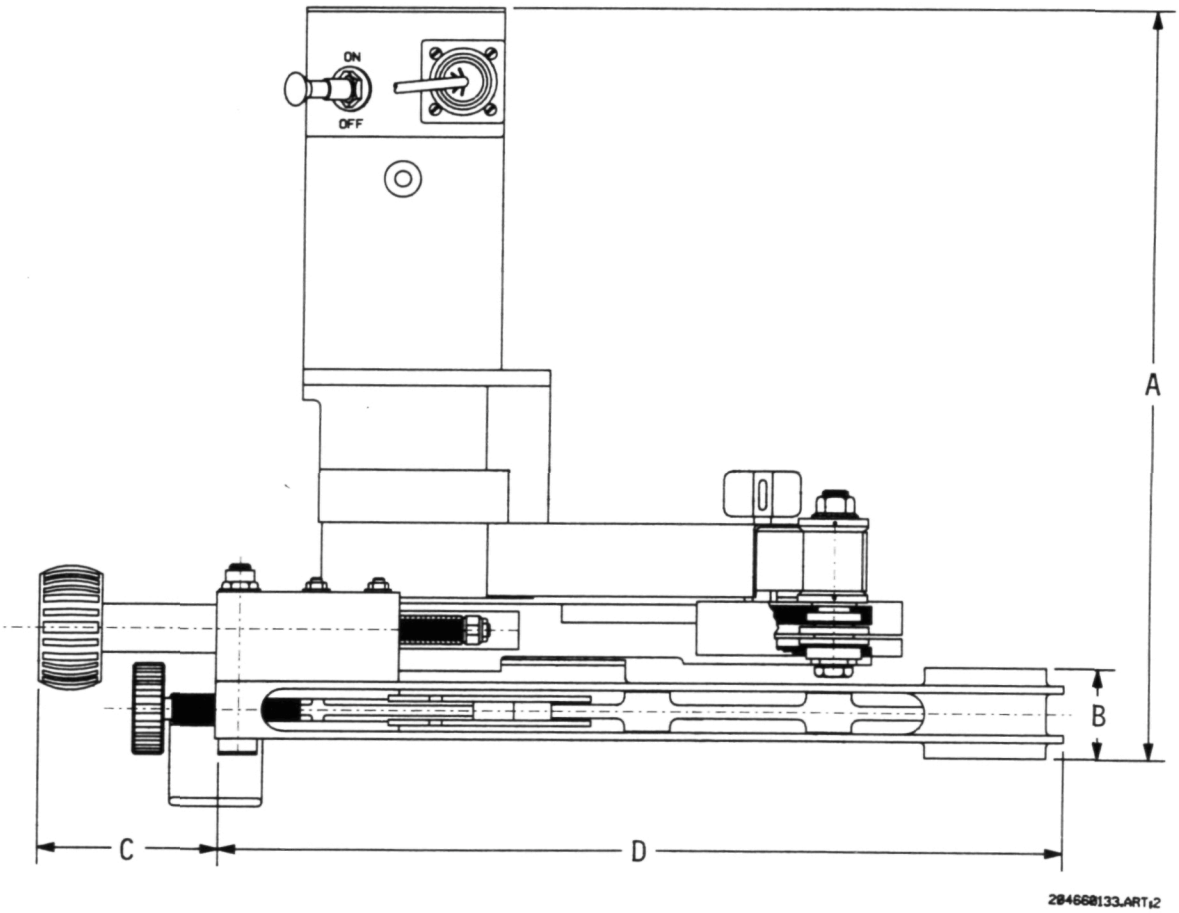
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: J. D. Bradley, NASA/ES6, (713) 483-8812
Source: J. D. Bradley, NASA/ES6, (713) 483-8812

SAW

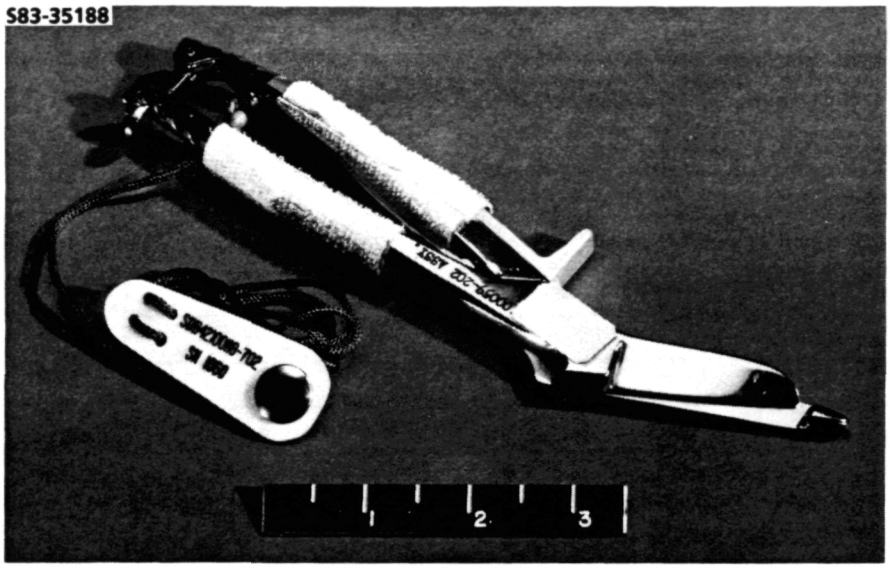
Technical Information	
Part number	SED33101842-307
Weight	12.5 lb
Material	Frame - stainless steel Motor and blade housings - aluminum Belt - Kevlar/polyurethane
Power requirements	400 cycle ac; external source 110 V
Blade speed	1100 rpm
Blade	4-in. diameter tungsten carbide blade, 5/8-in. arbor
Maximum depth of cut	1.25 in.
Availability	Developmental

Dimensional Data	
A	12.125 in.
B	1.500 in.
C	2.813 in.
D	13.875 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

SCISSORS, EMU



OVERVIEW

The extravehicular mobility unit (EMU) scissors are commercially available steel cast cutters with one serrated edge which have been modified with a hand stop for ease in performing EVA tasks. The handles are partially wrapped with Velcro. The scissors are stowed in a pocket on the front of the right thigh of the EMU.

OPERATIONAL COMMENTS

These scissors are capable of cutting anything from fabric bags and straps to lightweight steel cable and Kevlar cord. A special cutting blade near the scissor hinge point will accept up to 0.125-inch-diameter cable or cord. They are restrained by a 4.5-foot lanyard that is snapped inside the pocket of the EMU. Once the EMU scissors are unstowed from their pocket, they are not easily restowed because of reach and visibility limitations.

Standard Orbiter provisioning for each mission includes one pair of scissors for each prime EMU.

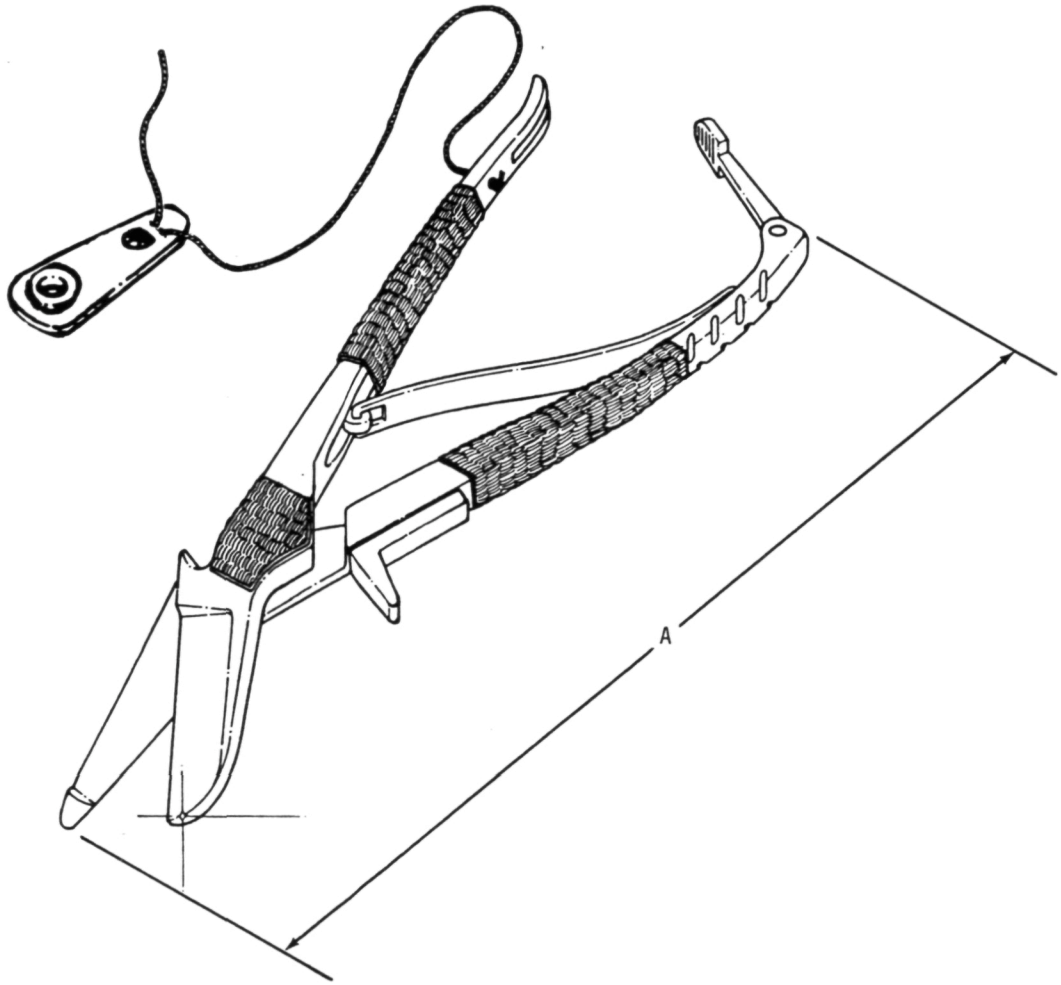
CONTACTS

Operational: C. H. Armstrong, NASA/DF42, (713) 483-2588
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: M. Withey, ILC Space Systems, (713) 488-9080

SCISSORS, EMU

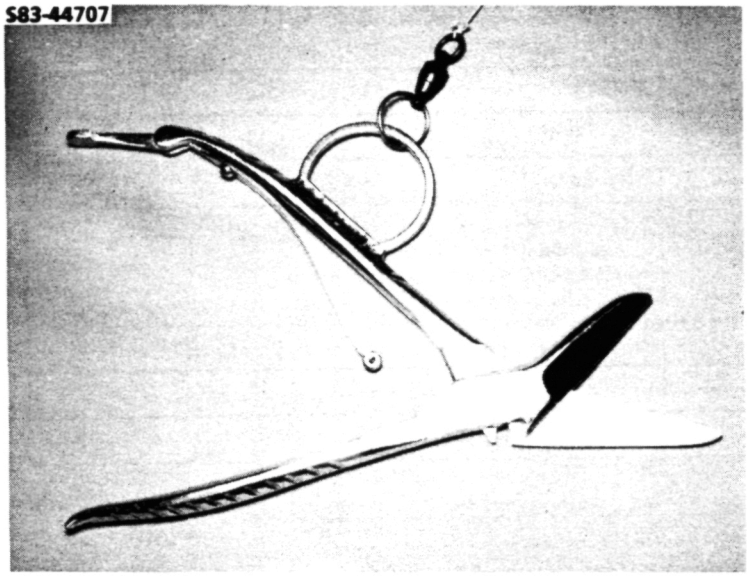
Technical Information	
Part number	10159-20001-02
Weight	0.75 lb
Material	Scissors - commercial steel cast cutters with one serrated edge Tether - 4.5-ft PBI cord
Tether breaking strength	94 lb
Quantity flown	One pair for each prime EMU
Stowage	EMU
Availability	Standard

Dimensional Data	
A	8.25 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

SCISSORS, MODIFIED



OVERVIEW

The modified scissors are commercially available steel cast cutters adapted for EVA use. They have one serrated cutting edge and are modified with a hand stop for ease of use by a suited crewmember. These scissors are a modification of the original extravehicular mobility unit (EMU) scissors with more sharply pointed blades and a tether ring welded to one handle.

OPERATIONAL COMMENTS

The modified EVA scissors can cut anything from fabric bags and straps to lightweight steel cable and Kevlar cord. A special cutting blade near the scissor hinge point will accept up to 0.125-inch-diameter cable or cord. The sharper points were designed to pierce insulation blankets. They have been successfully used on orbit to cut thermal blankets (multilayer insulation), grounding straps, Kapton tape, and nylon tie-wraps.

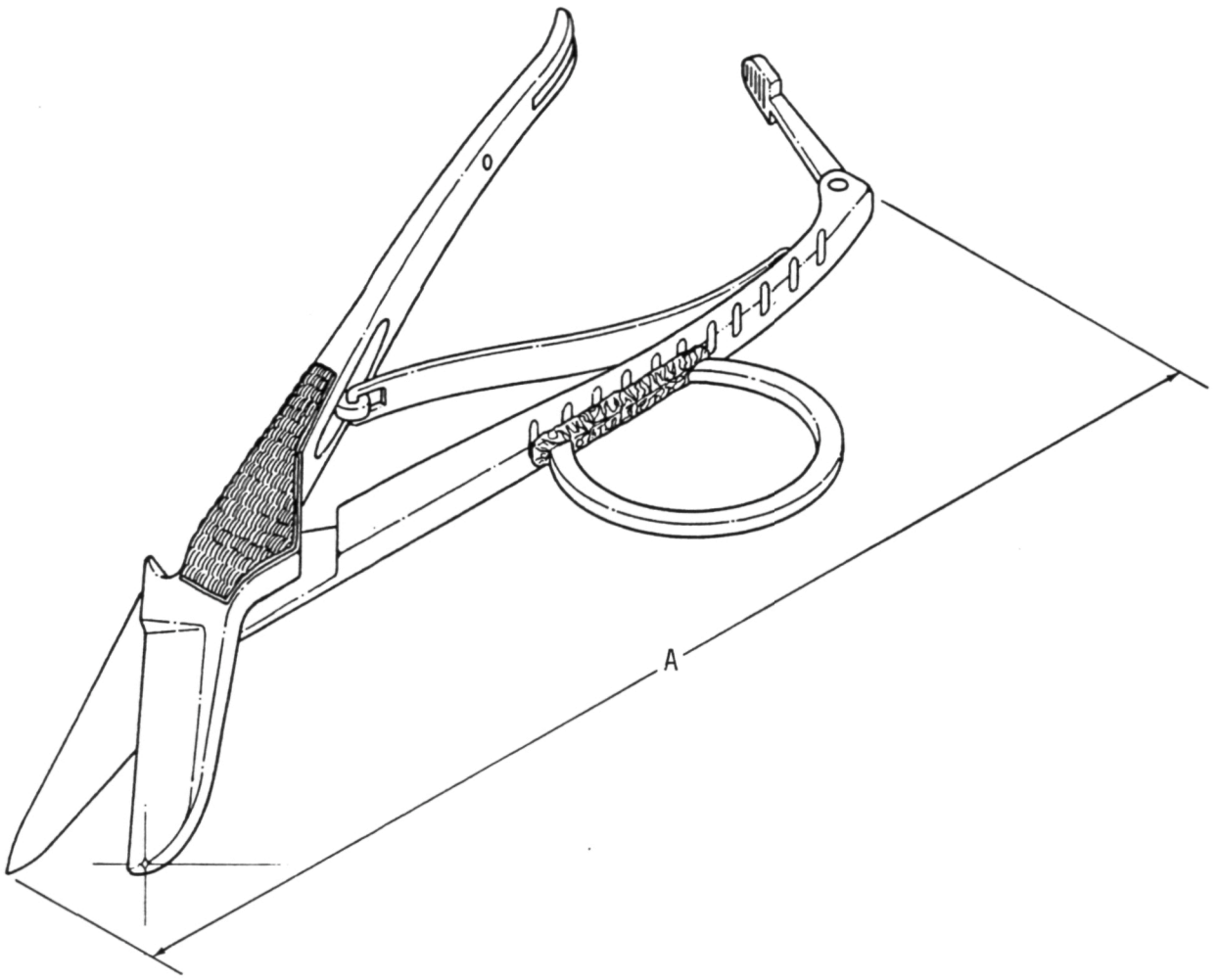
CONTACTS

Operational: C. H. Armstrong, NASA/DF42, (713) 483-2588
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

SCISSORS, MODIFIED

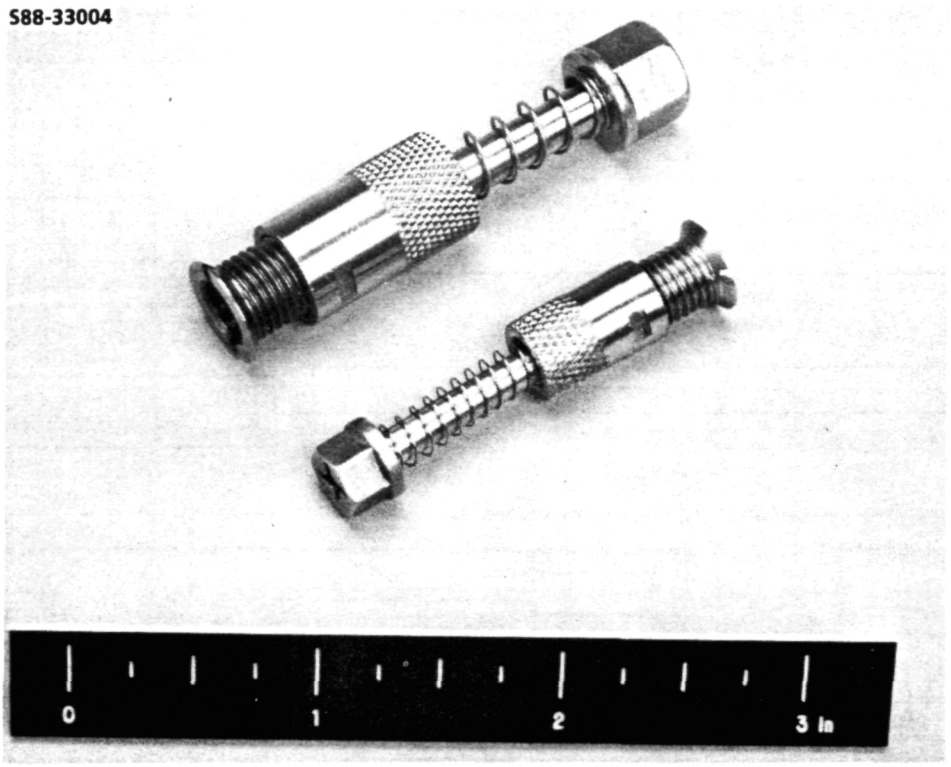
Technical Information	
Part number	10159-20076-01
Weight	0.75 lb
Material	Stainless steel
Quantity flown	As needed
Stowage	Tool board #1 in special equipment stowage assembly for STS 41-B Tool board #1 on STS 51-A Tool board #6 on STS 51-I
Availability	Flight specific

Dimensional Data	
A	8.25 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

SCREWS, EVA CAPTIVE



OVERVIEW

These captive screws are designed in two different hex head sizes for Hubble Space Telescope (HST) hardware installation. The fastener was designed to remain attached to the flight hardware during changeout operations. The fastener consists of two parts: a retainer nut and a captive screw assembly. The fastener is assembled in a housing with a spring to extend the fastener when loosened. The captive screw assembly is mounted to the hardware mounting flange with the retainer nut.

OPERATIONAL COMMENTS

The captive screws used on HST hardware are 5/16- and 7/16-inch hex head fasteners. Each captive fastener has two mechanical interfaces. It can be accessed with a 5/16- or 7/16-inch hex socket or a number 10 torque-set tip tool. For HST applications, the 7/16-inch captive fastener requires torque of 90 to 110 in-lb. The 5/16-inch fasteners require torques of 35-45 in-lb. The retainer nut seating torque for the 7/16-inch fastener is 110-130 in-lb and 80-100 in-lb for the 5/16-inch fastener.

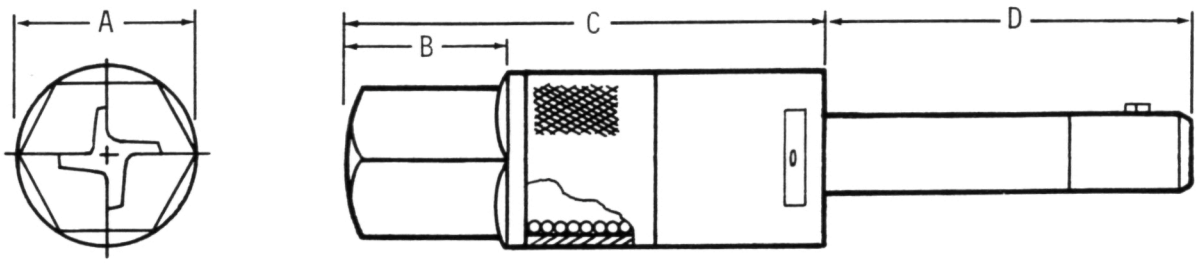
CONTACTS

Operational: S. P. Boyd, NASA/DF42, (713) 483-1755
Technical: H. T. Greenfield, LMSC/DEPT 6430, (408) 742-5799
Source: LMSC, HST Contracts Office, (408) 742-5505

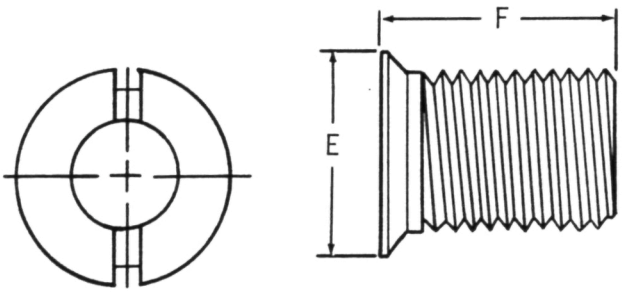
SCREWS, EVA CAPTIVE

Technical Information	
Part number	1622481-001-06 through 16 (5/16 hex) 1622481-002-07 through 16 (7/16 hex) 1622506-001 through 007 (retainer nut)
Weight	0.0309 lb max. (1622481-001-16) 0.0649 lb max. (1622481-002-16) 0.0083 lb max. (1622506-001)
Material	Corrosion resistant steel, Vespel (1622481-XXX-XX) 18-8 type 300 cres (1622506-XXX)
Availability	Flight specific

Dimensional Data		
	5/16 hex	7/16 hex
A	0.370 in.	0.500 in.
B	0.250 in.	0.375 in.
C	0.875 in.	1.250 in.
D	0.375 to 1.000 in.	0.437 to 1.000 in.
Retainer nut		
E	0.430 in. (001-003) 0.490 in. (004-007)	
F	0.375 to 0.781 in. (0.125 increments)	



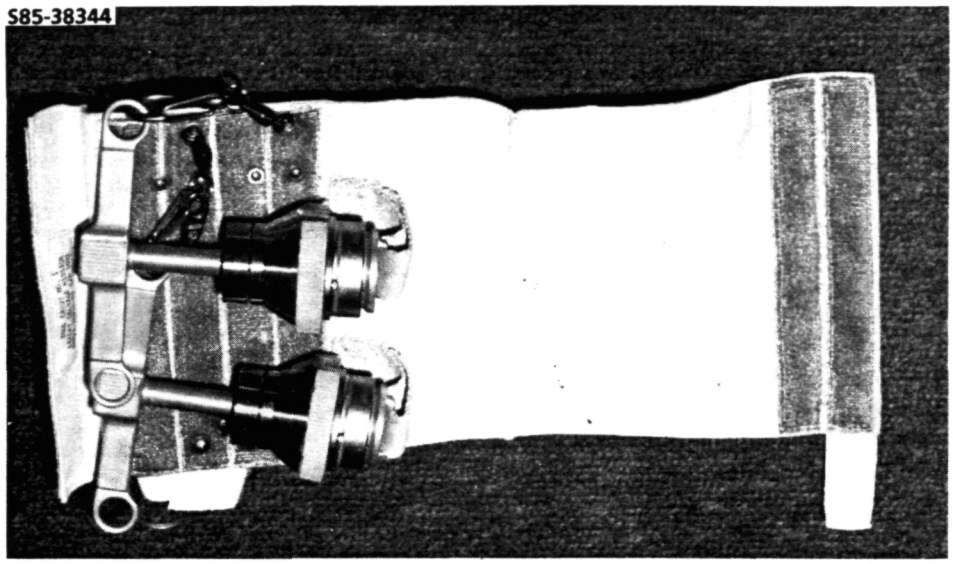
SCREW ASSEMBLY



RETAINER NUT

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

SHORTING PLUG



OVERVIEW

The shorting plug assembly consists of a shorting plug, a handle, and a dust cap/protective cover. The shorting plug was designed to mate/interface with the Leasat umbilical electrical connector. The handle, with its pushbutton release mechanism, was used to remove the plug from and install the plug onto the umbilical connector.

OPERATIONAL COMMENTS

The handle is installed onto the plug by pushing it through the slot located at the top of the shorting plug. The handle locks itself into place. The shorting plug is then installed onto the electrical connector and the handle is removed by pushing its release button. The shorting plug remained installed on the Leasat umbilical electrical connector. The dust cap/ protective cover was used to protect the plug from contamination when not in use.

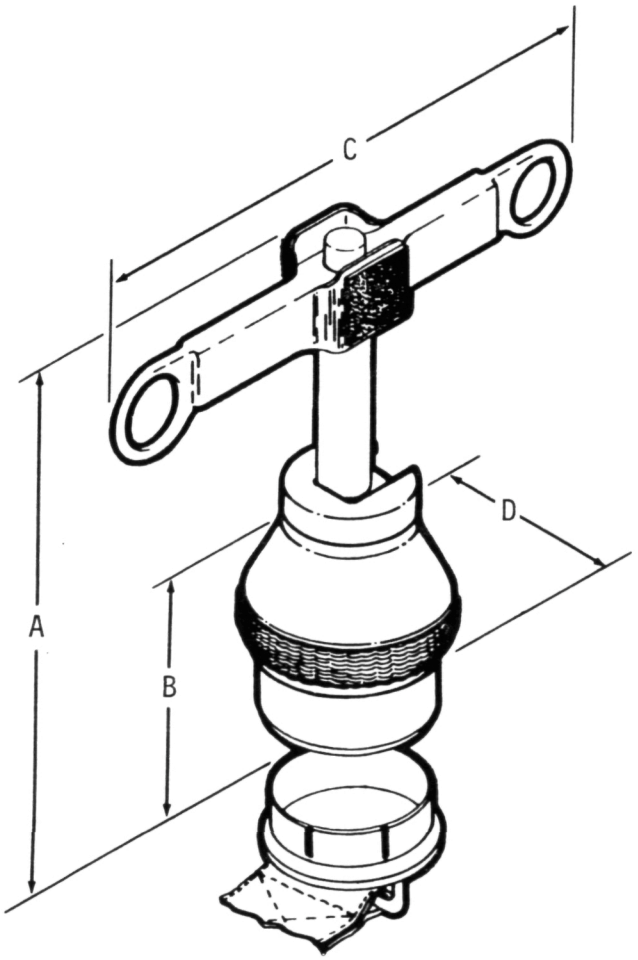
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 488-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

SHORTING PLUG

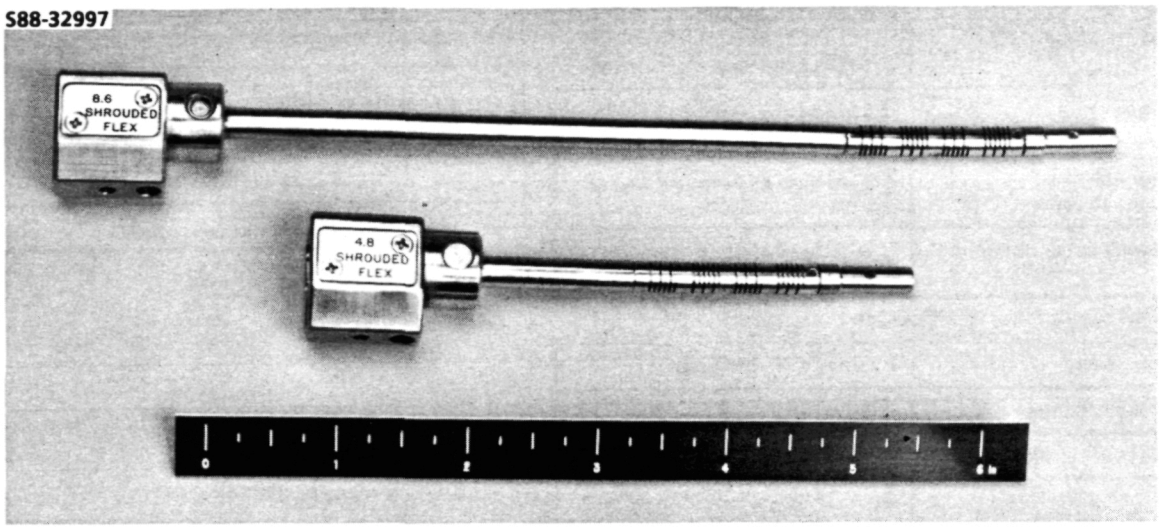
Technical Information	
Part number	10176-20111-01 (With T-handle) 10176-20111-02 (Without T-handle) 10176-20113-01 (T-handle)
Weight	0.90 lb
Material/ construction	Aluminum Stainless steel
Temperature range	-130° to +150° F (operational)
Availability	Flight specific

Dimensional Data	
A	5.20 in.
B	2.60 in.
C	5.88 in.
D	2.28 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

SHROUDED FLEX SCREWDRIVER



OVERVIEW

The shrouded flexible screwdrivers have a straight slot screwdriver tip with a static shroud to capture number 4 fillister-head screws. One design has a 7-1/4-inch shaft extension and the other has a 3-1/2-inch extension. Both provide an approximate flex of 40° at the tip. Each tool has a drop-proof tether fitting to prevent accidental loss.

OPERATIONAL COMMENTS

These screwdrivers were designed for use during maintenance of the Hubble Space Telescope (HST). A typical HST application involves small screws restraining electrical D-connectors. The approximate 40° total flex angle of the shrouded tip allows access to difficult-to-reach areas, especially around bends.

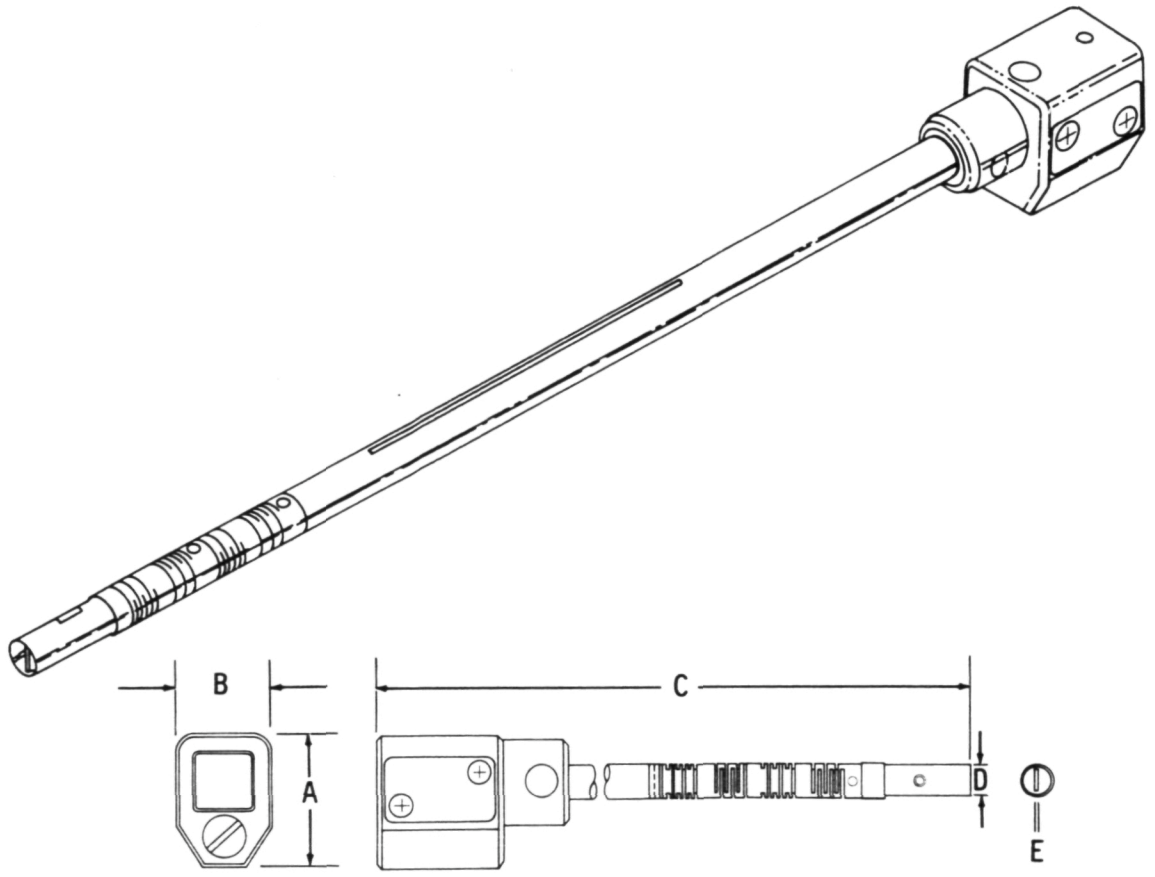
CONTACTS

Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

SHROUDED FLEX SCREWDRIVER

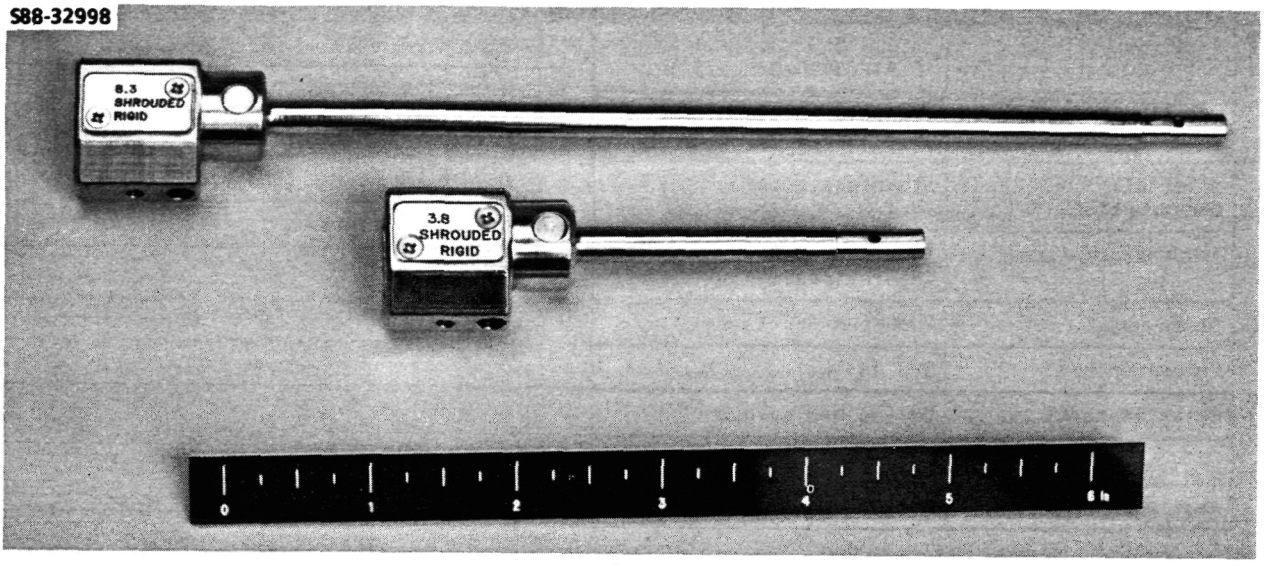
Technical Information	
Part number	10181-10019-01 4.8 in. 10181-10019-02 8.6 in.
Weight	10181-10019-01 0.17 lb 10181-10019-02 0.22 lb
Material/ construction	Stainless steel
Temperature range	-150° to +250° F (operational)
Flex angle	40° included
Screw head	Number 4 fillister
Force/torque	9.0 in-lb
Rotation marks	On tip and shroud
Availability	Flight specific

Dimensional Data	
A	0.93 in.
B	0.66 in.
C	4.83 in. (-01) 8.58 in. (-02)
D	0.22 in. (OD) 0.183 in. (ID)
E	0.03 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

SHROUDED RIGID SCREWDRIVER



OVERVIEW

The shrouded rigid screwdrivers have a straight slot screwdriver tip with a static shroud to capture number 4 fillister-head screws. They were designed with two extension lengths for optimum worksite selection. The screwdriver has a drop-proof tether to prevent accidental loss.

OPERATIONAL COMMENTS

The shrouded rigid screwdrivers were designed for use during maintenance of the Hubble Space Telescope (HST). A typical HST application involves small screws restraining electrical D-connectors.

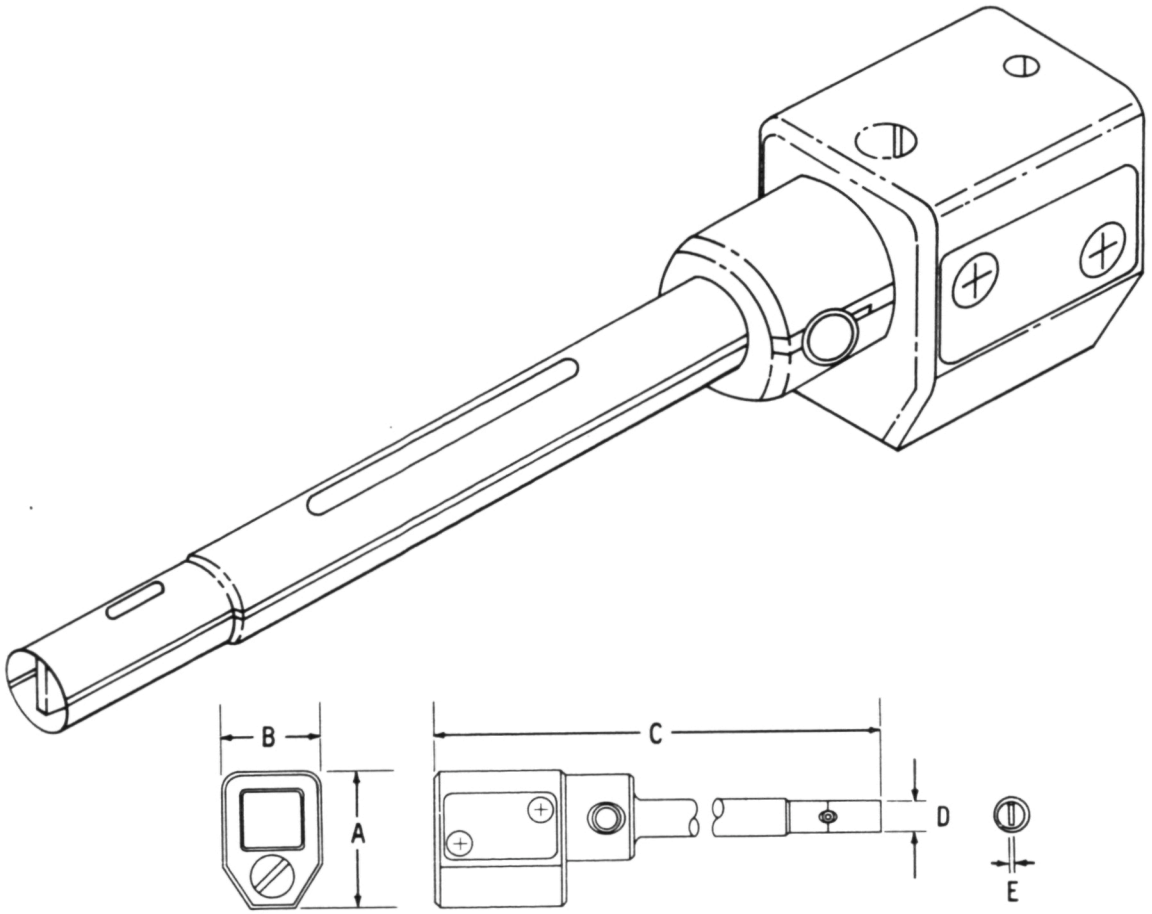
CONTACTS

Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

SHROUDED RIGID SCREWDRIVER

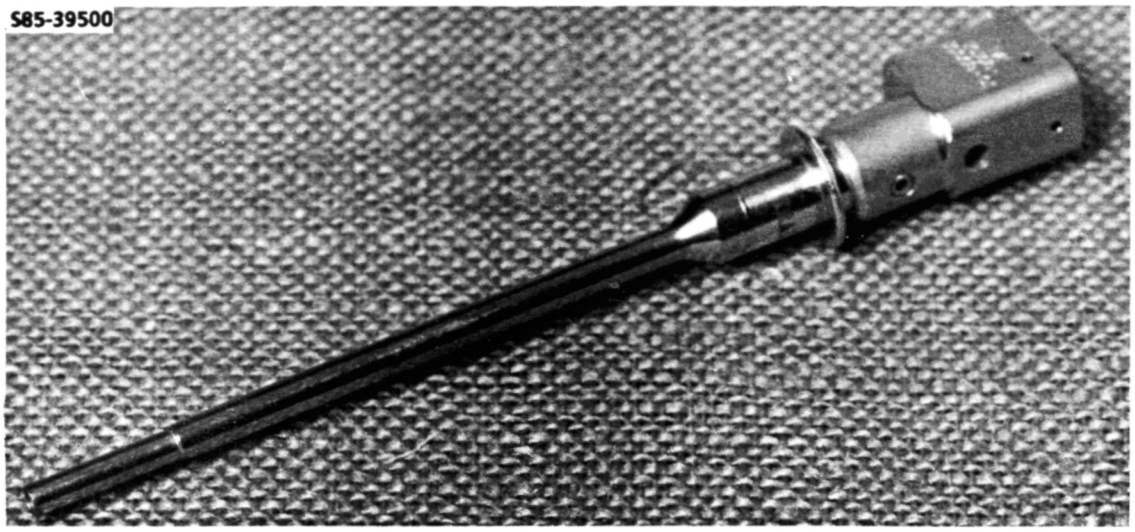
Technical Information	
Part number	10181-10020-01 3.8 in. 10181-10020-02 8.3 in.
Weight	10181-10020-01 0.20 lb 10181-10020-02 0.27 lb
Material/ construction	Stainless steel
Temperature range	-150° to +250° F (operational)
Screw head	Number 4 fillister
Force/torque	9.0 in-lb
Rotation marks	On tip and shroud
Availability	Flight specific

Dimensional Data	
A	0.93 in.
B	0.66 in.
C	3.83 in. (-01) 8.30 in. (-02)
D	0.22 in. (OD) 0.183 in. (ID)
E	0.03 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

SHROUDED SCREWDRIVER EXTENSION FOR 3/8-INCH DRIVE



OVERVIEW

The shrouded screwdriver extension for 3/8-inch drive is a straight slot screwdriver tip with a static shroud to capture number 4 screws. It has a drop-proof tether to prevent loss and can be used with any 3/8-inch drive tool that has a drop-proof tether attachment.

OPERATIONAL COMMENTS

The shrouded screwdriver extension was designed for use on the Solar Maximum Satellite (Solar Max) Repair Mission. It was stowed in the flight support system (FSS) locker. A quick-release pin is used to connect the shrouded screwdriver extension to, or disconnect it from, 3/8-inch drive tools.

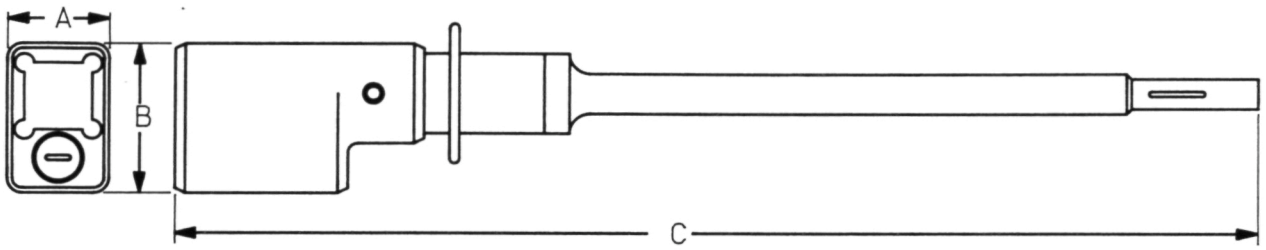
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

SHROUDED SCREWDRIVER EXTENSION FOR 3/8-INCH DRIVE

Technical Information	
Part number	10172-20556-01
Weight	0.35 lb
Material	Base - stainless steel
Quantity flown	One
Stowage	FSS locker, in a tool caddy
Availability	Flight specific

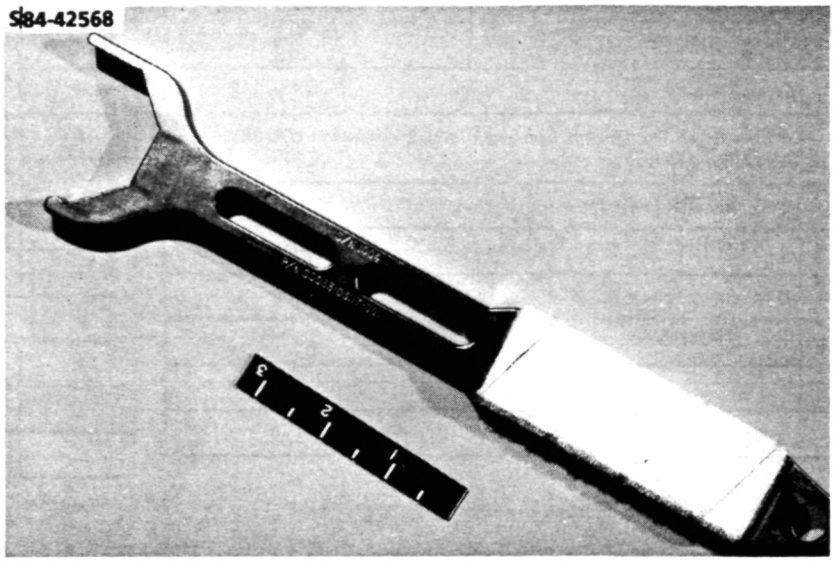
Dimensional Data	
A	0.70 in.
B	1.00 in.
C	7.50 in.



204660101.ART,3

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

SHUTTLE UMBILICAL RETRACTION SYSTEM WRENCH



OVERVIEW

The Shuttle umbilical retraction system (SURS) wrench functions as a spanner wrench. The wrench works only on hex nuts and has a jaw opening of 1-15/16 inches. The handle is wrapped with Velcro to provide a sure grip for the gloved hand and has a built-in ring for tethering. This wrench was flown for Shuttle pallet satellite (SPAS) and will be used for Gamma Ray Observatory (GRO).

OPERATIONAL COMMENTS

The SURS wrench is a jam removal tool used when the payload umbilical release mechanism jams. It is used to loosen the torque nut and then to pry apart the connector. The tool can also be used to loosen jammed portable foot restraint knobs or to disconnect any 1-15/16-inch hex nut. This tool is part of the normally manifested STS equipment and is stowed in the port provisions stowage assembly (PSA).

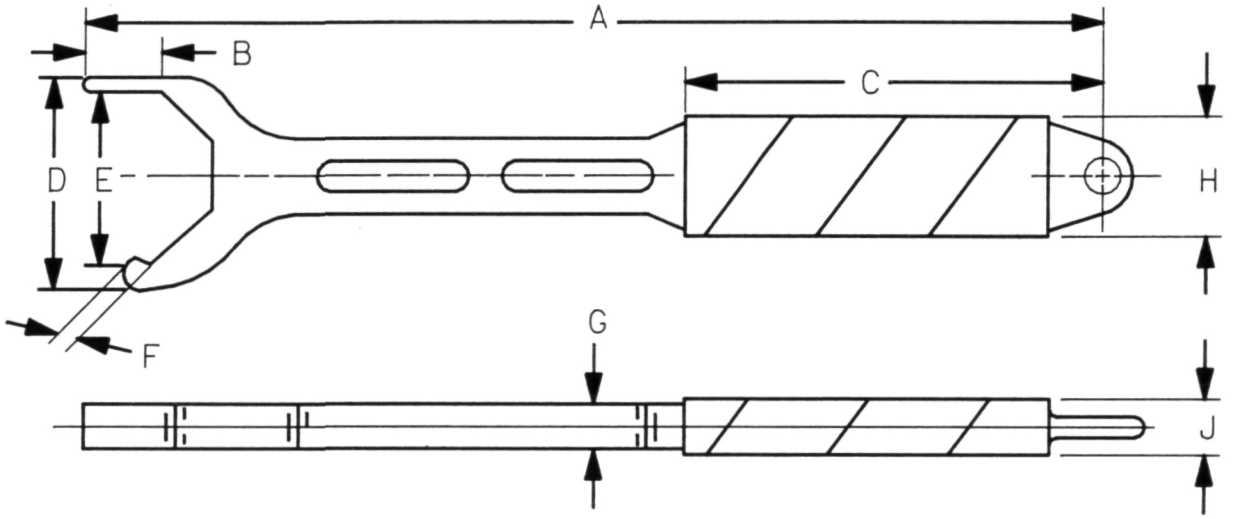
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: T. Ross, NASA/ES6, (713) 483-8941

SHUTTLE UMBILICAL RETRACTION SYSTEM WRENCH

Technical Information	
Part number	SDD33103117-001
Weight	2.0 lb
Material/ construction	#496 oil-hardened AISI-01 steel electroless nickle plating
Torque limit	240 in-lb (maximum)
Jaw opening	1.940 in. (~ 1-15/16 in.)
Quantity flown	One in the port PSA
Availability	Standard

Dimensional Data	
A	11.18 in.
B	0.81 in.
C	4.70 in.
D	2.20 in.
E	2.00 in.
F	0.12 in.
G	0.50 in.
H	1.38 in.
J	0.63 in.

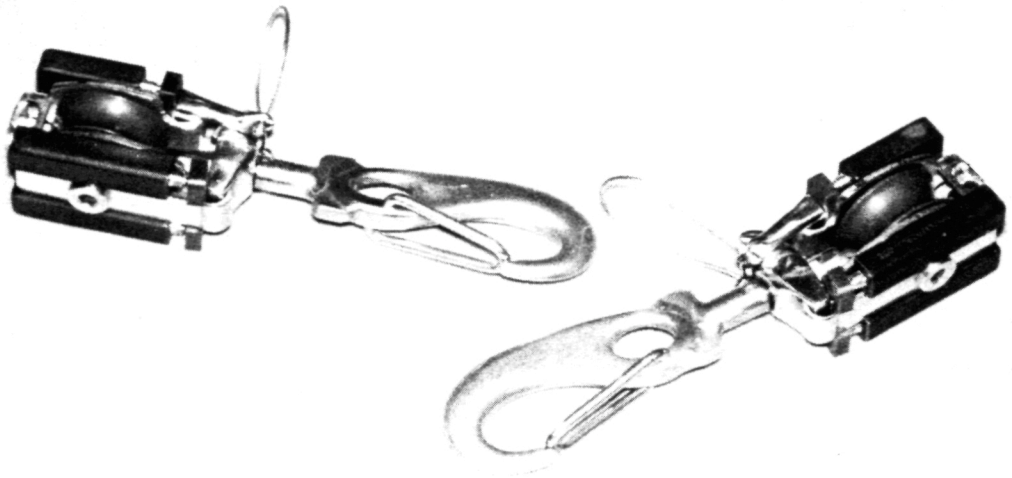


204660136.ORT, 7

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

SNATCH BLOCK

S84-39407



OVERVIEW

The snatch block is a common marine device modified for EVA use. It is commonly used with a 3/8-inch-diameter rope. The snatch block hook has a snap lock to provide a more secure attachment. The hook has an opening of 0.78 inch and is attached by a swivel shaft allowing 360° rotation.

OPERATIONAL COMMENTS

The snatch block is used to route the cargo bay winch line to support payload tasks. In the event of remote manipulator system (RMS) failure, it is also used in conjunction with the RMS rope reel to backdrive the RMS to a stowed position. If a failure should occur in the inertial upper stage (IUS) tilt table, the snatch block can be used to raise and lower the IUS for deploy and stowage. It is part of the normally manifested Space Transportation System (STS) equipment and is stowed in the starboard provisions stowage assembly (PSA).

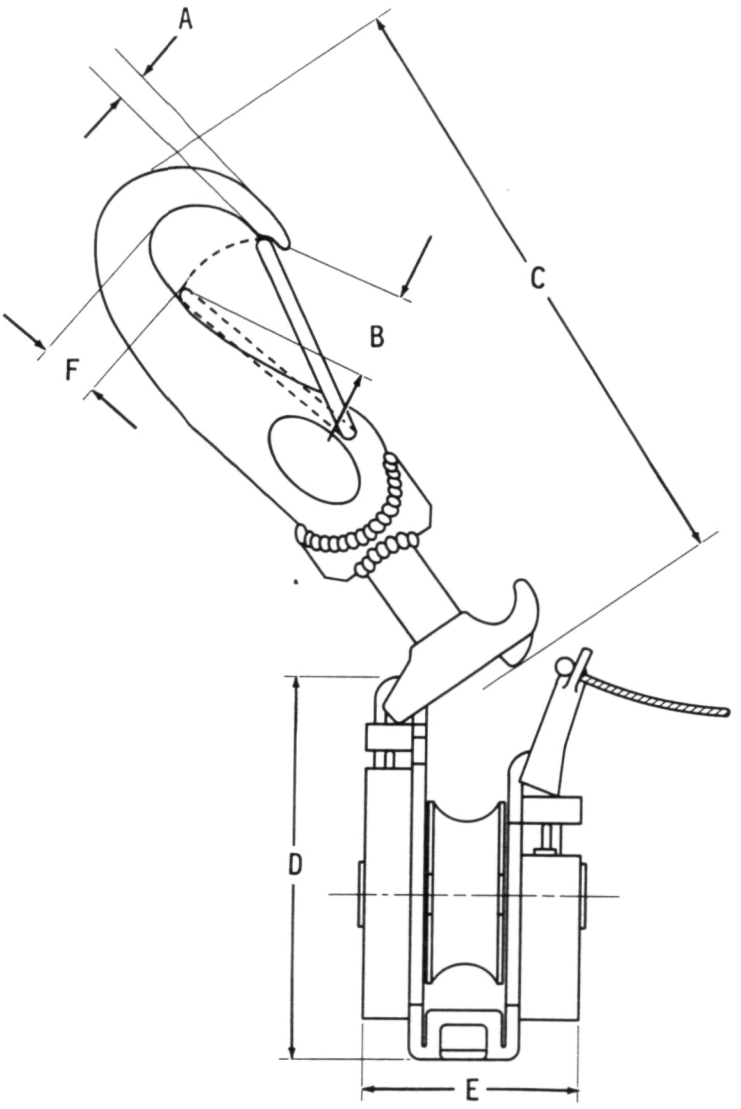
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: T. Ross, NASA/ES6, (713) 483-8941
Source: T. Ross, NASA/ES6, (713) 483-8941

SNATCH BLOCK

Technical Information	
Part number	SED33102357-303. (10163-20057-01 hook)
Weight	1.66 lb
Material	Stainless steel frame and hook Aluminum pulley wheel
Temperature range	-200° to 250° F (operational)
Quantity flown	Two in the starboard PSA
Availability	Standard

Dimensional Data	
A	0.25 in.
B	0.78 in.
C	6.00 in.
D	3.75 in.
E	2.00 in.
F	0.75 in.

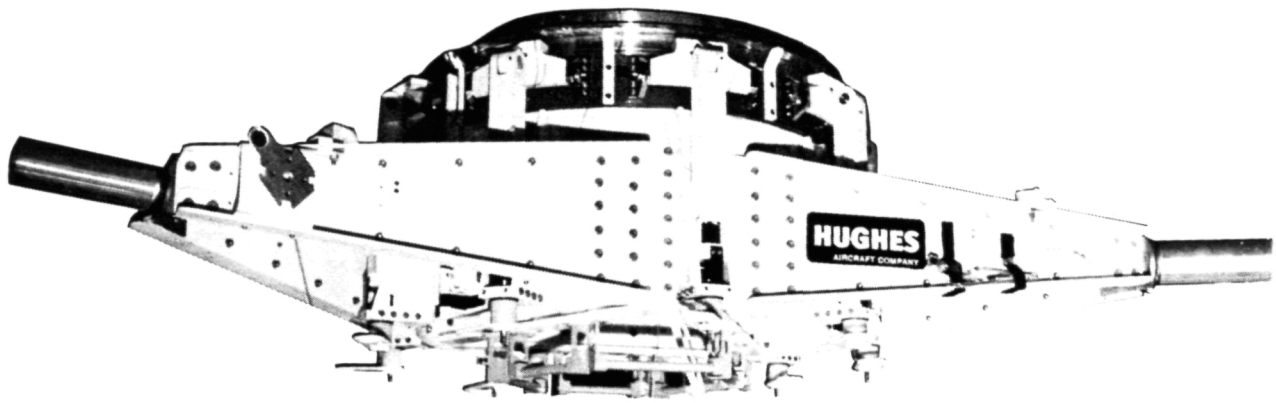


204660137.ART, 3

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

SPACECRAFT ADAPTER

S84-42435



OVERVIEW

The spacecraft adapter structure (SAS), also known as the spacecraft adapter, was designed for the Hughes communication satellite retrieval mission. The structure is latched to the apogee kick motor (AKM) adapter ring of the Hughes HS376 satellite and then mounted to a Spacelab pallet for reentry. It was used for the Westar VI and Palapa B-2 satellites. Two identical spacecraft adapters exist.

OPERATIONAL COMMENTS

The SAS is released from the Spacelab pallet by opening the payload retention latches which capture three trunnions equipped with scuff plates. The EVA crewmembers remove the SAS and position it for soft docking with three capture latches. Next, they hard dock the adapter to the satellite by tightening the 7/16-inch drive screws of nine additional latches using the EVA power tool and EVA torque wrench. A grounding strap is attached to the satellite, and it is docked in the cargo bay by using the payload retention latch assemblies. Two EVA crewmembers are recommended for SAS installation. This is a payload-unique device and is not normally flown.

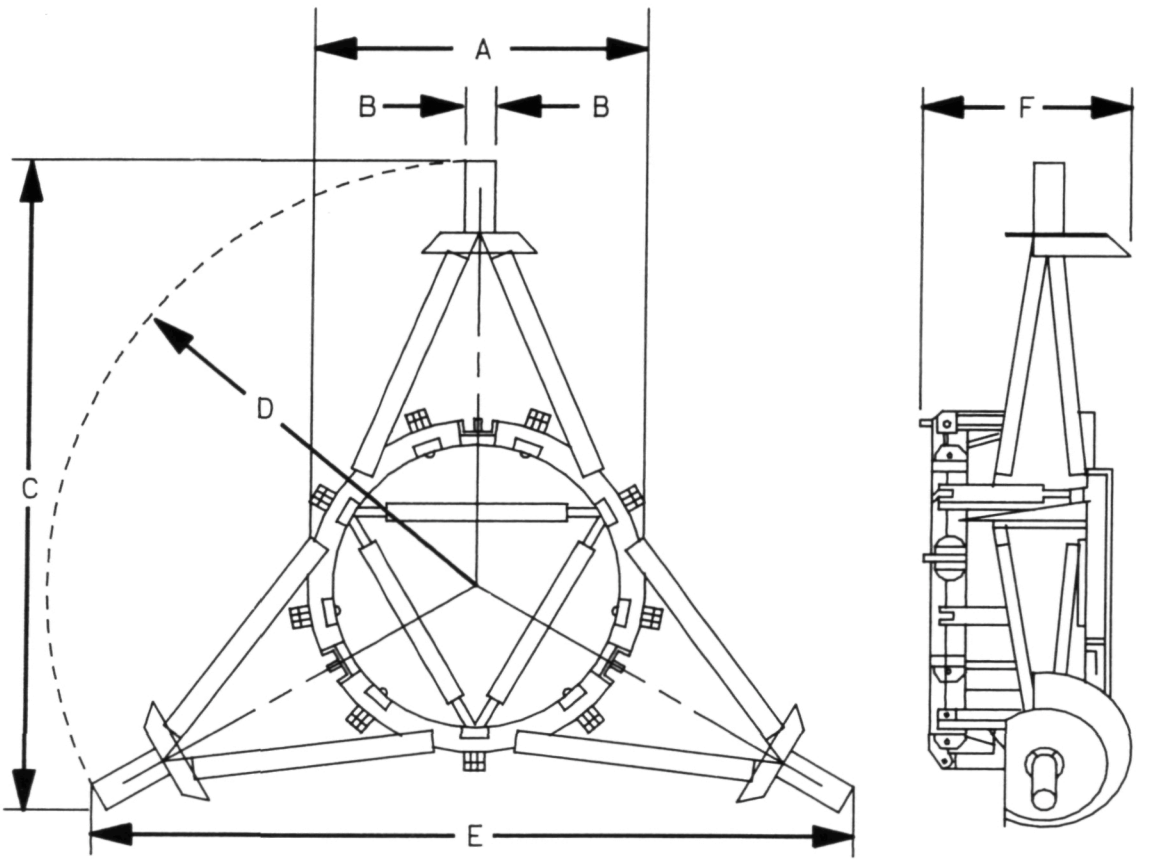
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: J. Pokras, Hughes Aircraft Co., (213) 648-4291
Source: J. Pokras, Hughes Aircraft Co., (213) 648-4291

SPACECRAFT ADAPTER

Technical Information	
Part number	4599883-200
Weight	544.64 lb
Material	Structure - 7075-T7351 aluminum Surface - Chemglaze A 276 white paint
Force/torque	Soft dock - negligible force Initial installation - 110 in-lb (HI setting on power tool) Final installation - 50 to 60 ft-lb (based on visual indicators)
Temperature range	-40° to 250° F
Availability	Flight specific

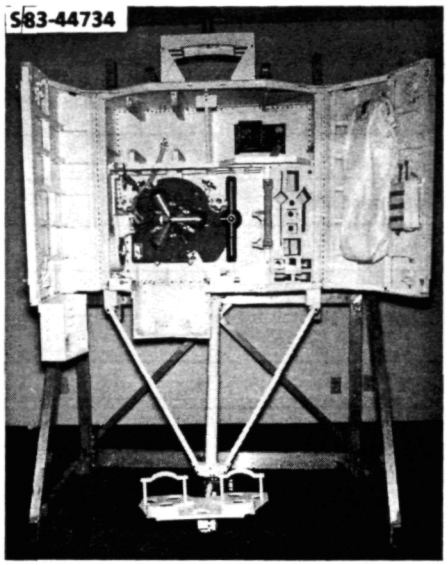
Dimensional Data	
A	42.0 in.
B	2.0 in.
C	81.0 in.
D	54.0 in.
E	93.0 in.
F	26.0 in.



204660138.ORT, 4

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

SPECIAL EQUIPMENT STOWAGE ASSEMBLY



OVERVIEW

The special equipment stowage assembly (SESA) was designed for the stowage of tools and equipment such as the trunnion pin attachment device (TPAD) and hydrazine servicing tools.

OPERATIONAL COMMENTS

The SESA is a modified cargo bay stowage assembly (CBSA) which includes a tripod with a mounted portable foot restraint. The shelves, foam, and door stowage compartment of the CBSA have been removed; partitions, handholds, mounting hardware, structural stiffeners, and clearance holes have been added. It was used during the STS 41-B practice mission for Solar Maximum satellite repair. A trunnion pin structure was attached to the SESA top for practicing manned maneuvering unit (MMU)/ TPAD operations.

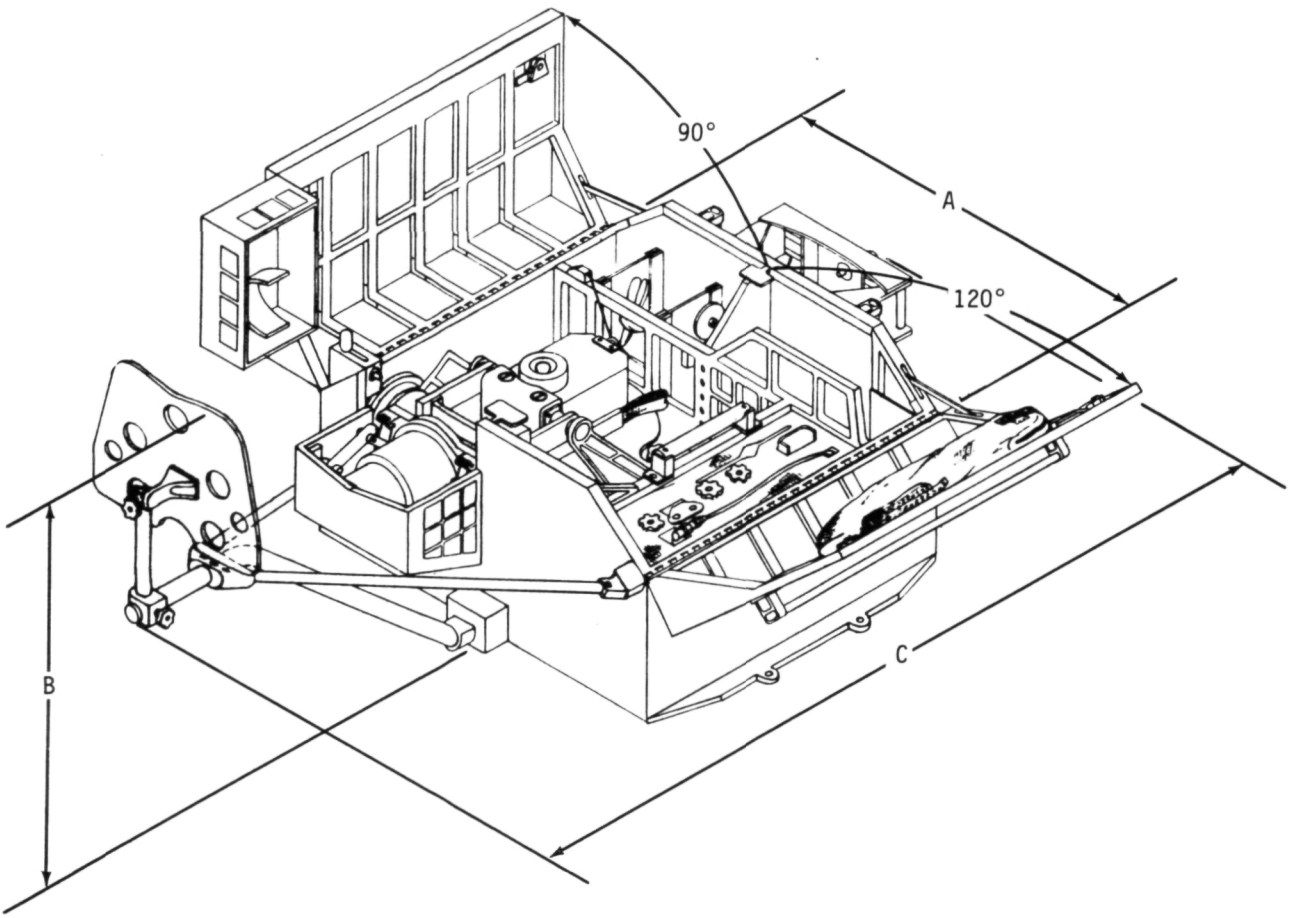
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

SPECIAL EQUIPMENT STOWAGE ASSEMBLY

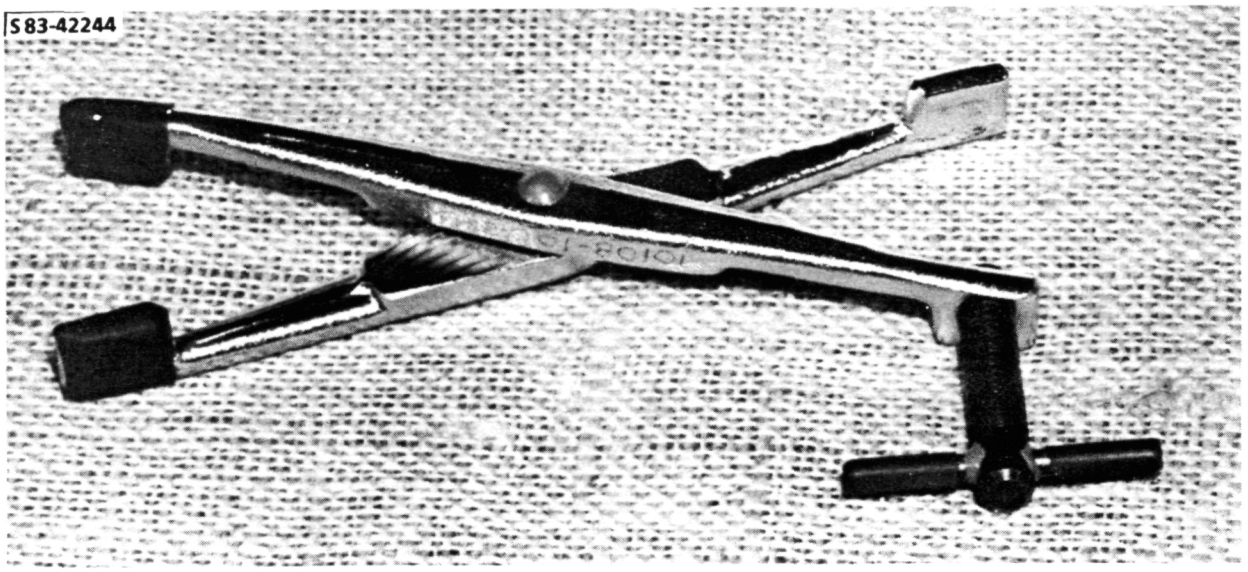
Technical Information	
Part number	10173-20001-01
Weight	246 lb (unloaded) 386 lb (loaded)
Material	Aluminum
Quantity flown	One (when needed)
Stowage	Payload bay
Availability	Flight specific

Dimensional Data	
A	48.10 in.
B	44.26 in.
C	92.66 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

SPREADER ASSEMBLY



OVERVIEW

The spreader assembly, also known as the extravehicular mobility unit (EMU) waist ring release, was originally designed as a contingency tool for separating the waist ring of the EMU lower torso assembly from that of the hard upper torso. The spreader is now used as a contingency tool to open the type D payload assist module (PAM-D) large sunshield if the sunshield fails to open electrically.

OPERATIONAL COMMENTS

The spreader assembly has rubber tips that are inserted between the two objects that are to be pried apart. Tightening a T-screw in one handle of the scissors-shaped tool against the other handle forces the rubber tips apart and holds them open.

When inserted into the rotary actuator of the large PAM-D sunshield, and the intravehicular (IV) crewmember display indicates open, the cables can safely be cut and the sunshield opened manually. A tether ring is added to the tool for this use.

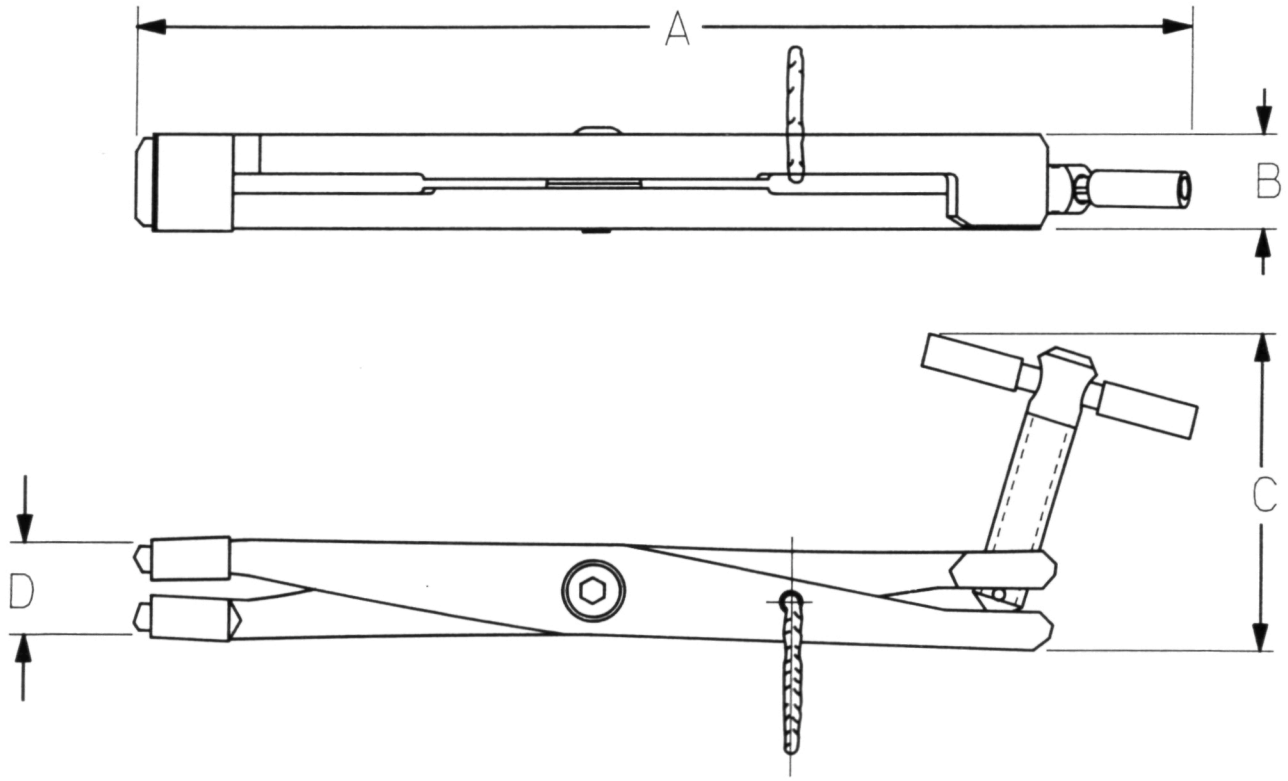
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

SPREADER ASSEMBLY

Technical Information	
Part number	10108-10021-02
Weight	0.51 lb
Material	Stainless steel
Quantity flown	One as required
Availability	Flight specific

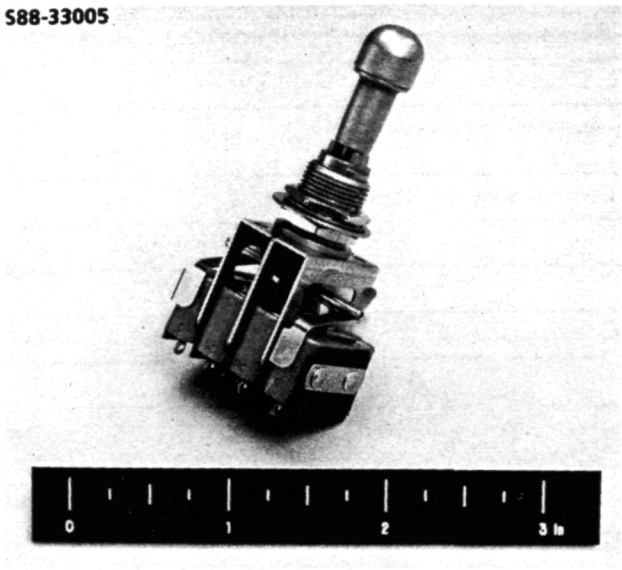
Dimensional Data	
A	7.69 in.
B	0.66 in.
C	2.22 in.
D	1.35 in. (max.)



204660056.ART, 2

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

SWITCH, EVA



OVERVIEW

The EVA switch is a commercially manufactured switch modified and certified for EVA use. It consists of a toggle switch lever and frame containing one or more basic microswitches. The switch is a modular assembly available in a variety of configurations, including two- or three-position locking switches and up to four ganged basic switches operated by the same lever.

The basic switches used in the assembly are hermetically sealed with glass-to-metal bead seals at the terminal entry points. They are inert-gas filled, have silver or gold contacts as required, and can switch resistive loads up to five amperes at 28 V dc or 115 V ac, 400 Hz.

OPERATIONAL COMMENTS

To prevent accidental operation, the spring-loaded locking levers must be pulled 0.09 inch upward to change positions. When released, the switch is locked in place. Depending on circuit requirements, various locking patterns can be specified, such as locked-in, locked-out, or unlocked at specific switch positions. Five of these switches are used on the EVA power package.

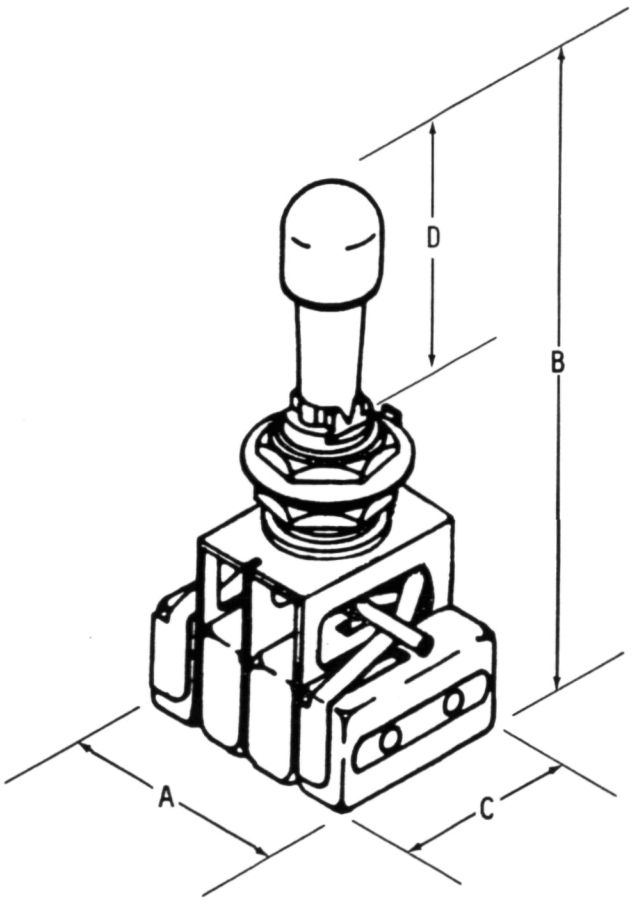
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

SWITCH, EVA

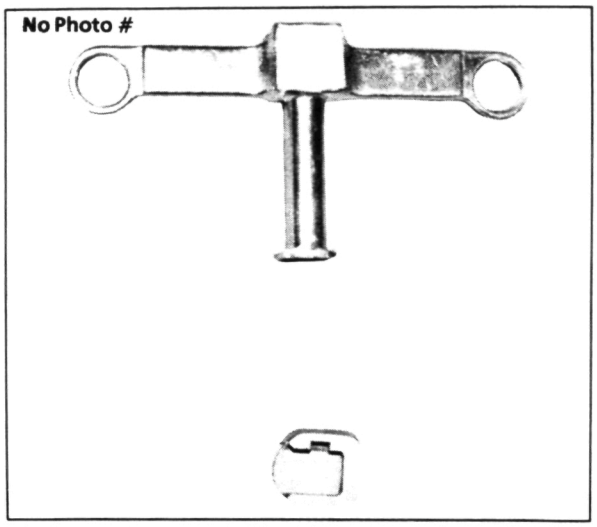
Technical Information	
Part number	S085MD1738-01
Weight	0.11 lb
Material/ construction	Toggle - stainless steel
Temperature range	-85° to +250° F (operational)
Availability	Flight specific

Dimensional Data	
A	1.31 in.
B	2.63 in.
C	0.84 in.
D	1.00 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

T-HANDLE



OVERVIEW

The T-handle is a detachable handle for use with small EVA tools.

OPERATIONAL COMMENTS

The T-handle makes a secure connection with tools and can be attached or detached with one hand by a suited EVA crewmember. A patch of hook Velcro on the handle provides secure attachment to a tool caddy.

The handle shank, which has a lip around the bottom, slides into a slot on the tool, where it is held by the lip. A spring-loaded section of the lip rises into a hidden notch in the slot to lock the handle in place. Pushing a button at the top center of the handle releases the spring-loaded section and allows the handle to slide back out of the slot. This T-handle has been used successfully on STS 51-I as a removable handle for the Syncom separation lever tool and for the electrical shorting plugs.

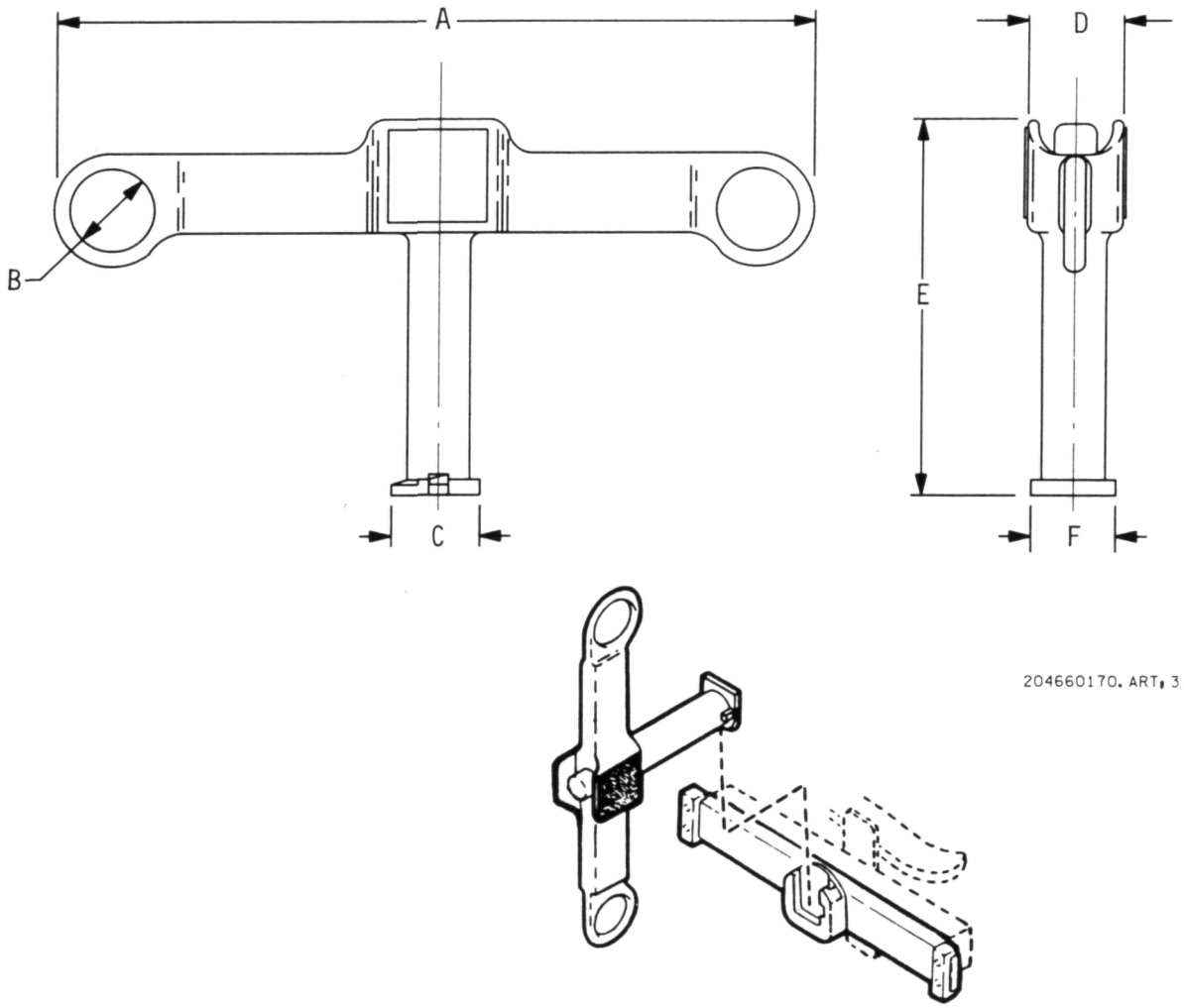
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

T-HANDLE

Technical Information	
Part number	10176-20113-01
Weight	0.17 lb
Material	Aluminum
Quantity flown	Three on STS 51-I
Availability	Flight specific

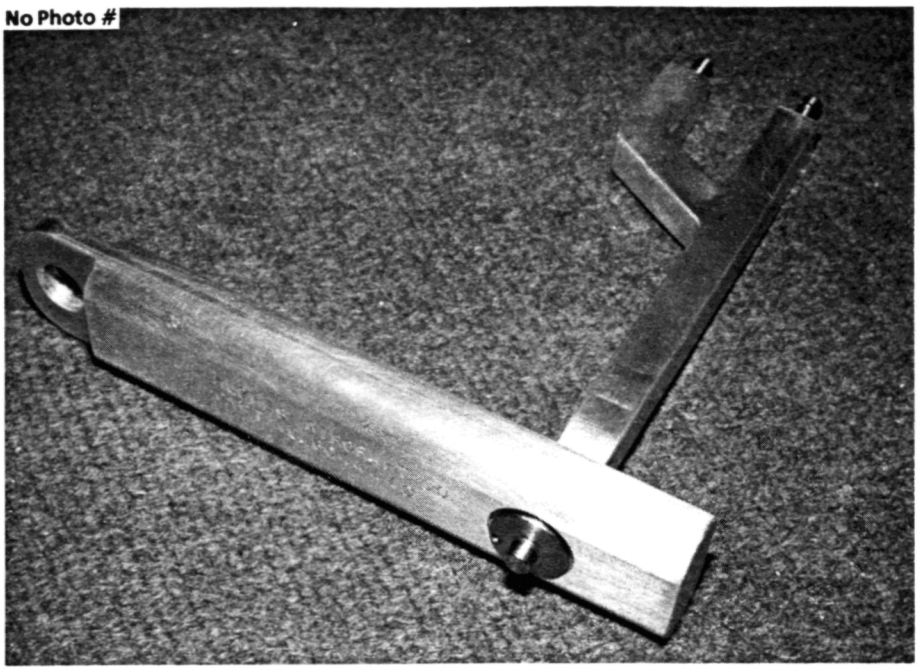
Dimensional Data	
A	5.88 in.
B	0.63 in.
C	0.69 in.
D	0.75 in.
E	2.88 in.
F	0.69 in.



204660170.ART, 3

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

T-HANDLE, ELECTRICAL CONNECTOR CAP



OVERVIEW

The electrical connector cap T-handle was designed for use on the Leasat Salvage Mission. Two T-handles, a prime and a spare, were flown on STS 51-I. They were stowed on tool boards no. 2 and no. 9 in the Leasat equipment stowage assembly (LESA).

OPERATIONAL COMMENTS

The T-handle was designed to install specially designed shorting plugs on exposed electrical connectors. A button on the top of the handle must be depressed to allow release of the handle from the shorting plug after it is installed on the connector. This tool is essentially a long pip pin built into an EVA-compatible handle.

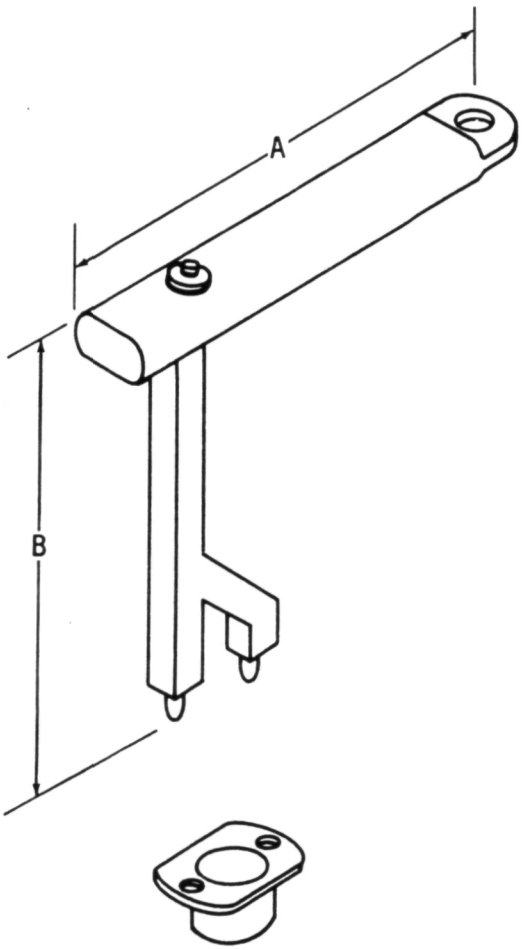
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2589
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: J. Pokras, Hughes Aircraft Co., (213) 648-4291

T-HANDLE, ELECTRICAL CONNECTOR CAP

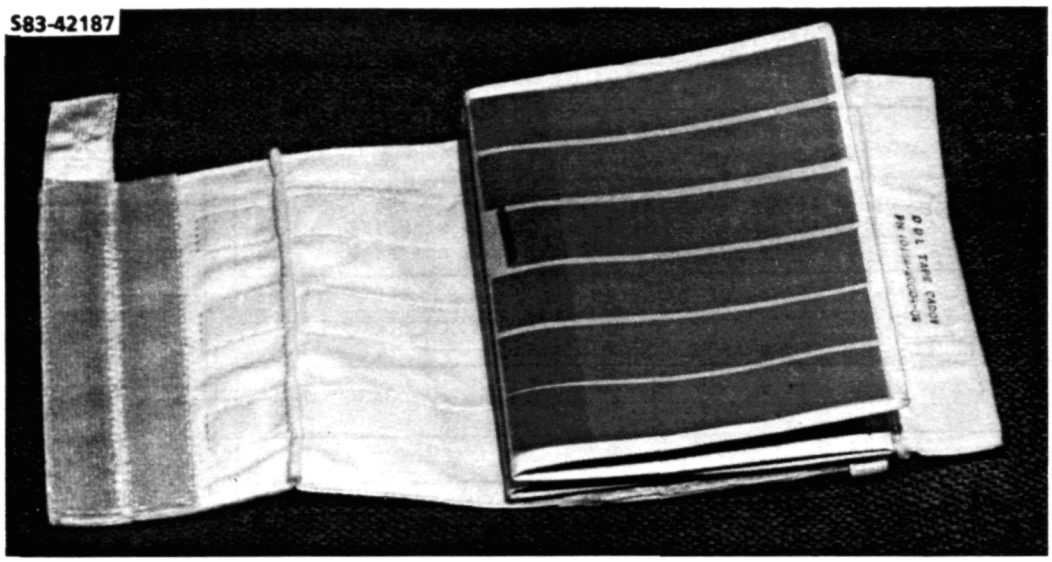
Technical Information	
Part number	6044440 (Hughes Aircraft Co.)
Weight	0.852 lb
Material	Aluminum
Temperature range	-150° to +250° F (operational)
Availability	Flight specific

Dimensional Data	
A	7.00 in.
B	6.75 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

TAPE CADDY, KAPTON



OVERVIEW

The Kapton tape caddy, also called the door drive linkage (DDL) tape set, is a foldup fabric tool caddy containing Kapton tape strips which are used for restraining disconnect mechanisms or loose hardware during EVA.

OPERATIONAL COMMENTS

The tape strips, which vary in length depending upon the configuration, adhere to both sides of a foldout section of Armalon material. A crewmember can pull off tape with little effort as it is needed. The tape strips are composed of three layers of Kapton to prevent curling. The caddy itself can be secured at work areas by use of the guide strap pull or interface adapter assembly. The -04 assembly is a standard flight item, and the tape is primarily used to hold up the door drive linkage. The -03 assembly was intended for use on the Solar Maximum mission. The holes in the 4-inch tape pieces were positioned over thermal washers.

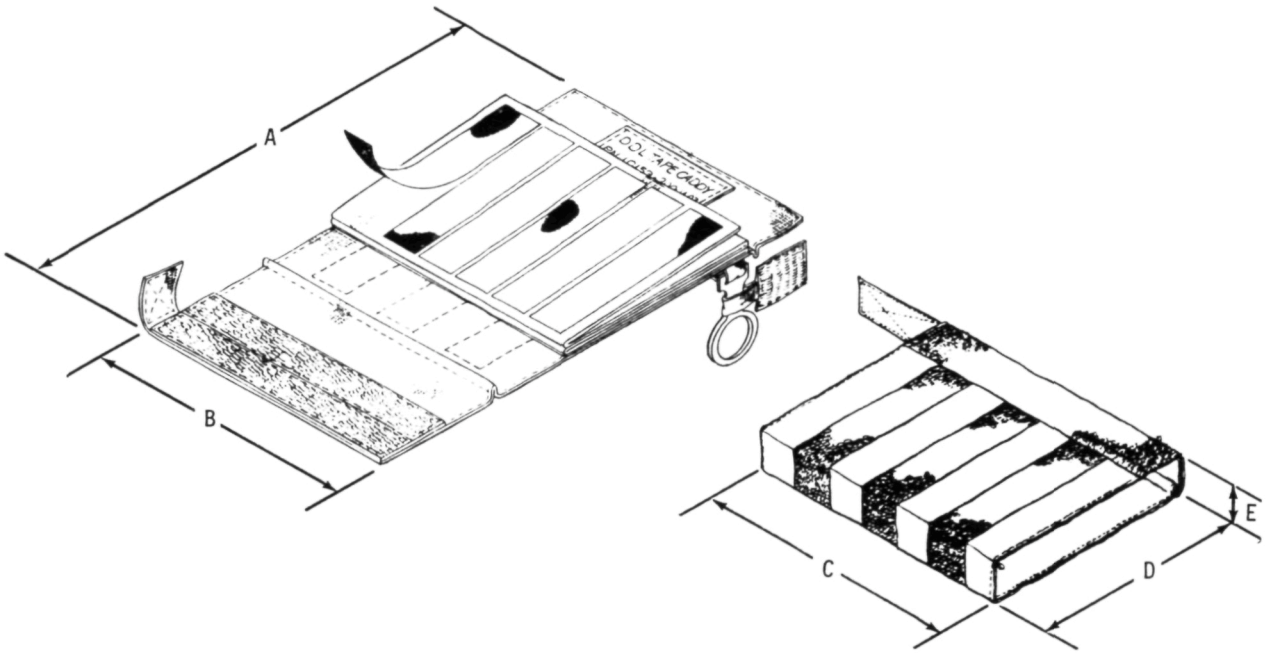
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: M. Withey, ILC Space Systems, (713) 488-9080

TAPE CADDY, KAPTON

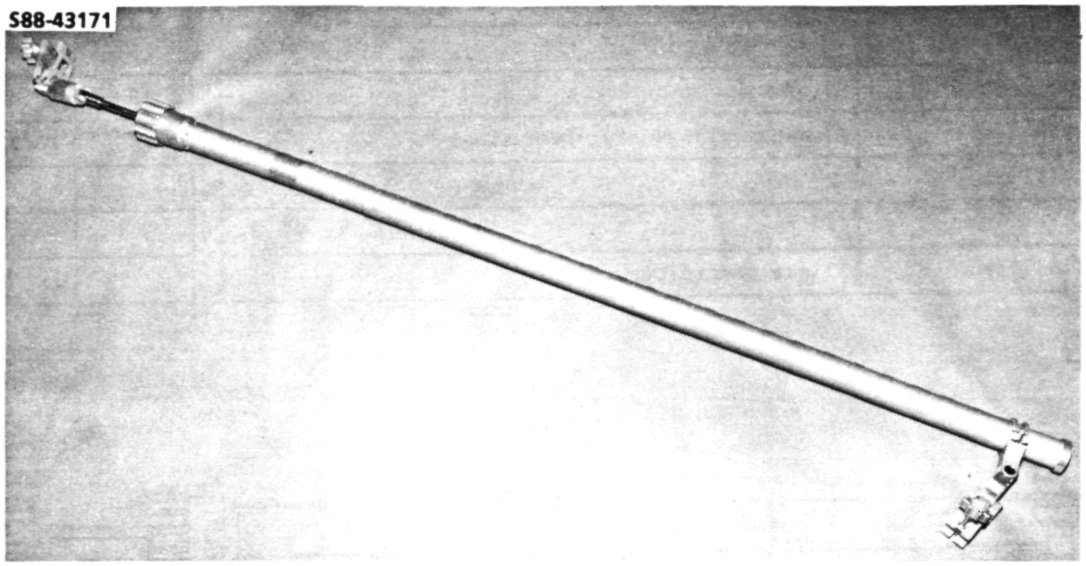
Technical Information	
Part number	10159-20004-03, -04
Weight	0.84 lb
Material	Caddy - Nomex and Armalon Kapton thermal tape
-03 configuration	20 strips of 1- by 5-in. Kapton 20 strips of 1- by 4-in. Kapton with 1/2-in.-dia hole punched 1-1/2 in. from one edge
-04 configuration	12 strips of 1- by 15-in. Kapton
Temperature range	-50° to 150° F (operational)
Tape tensile strength	30 in-lb
Quantity flown	One
Stowage	Starboard provisions stowage assembly
Availability	Standard

Dimensional Data	
A	14.5 in.
B	7.5 in.
C	7.0 in.
D	5.5 in.
E	1.0 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

TELESCOPING BOOM



OVERVIEW

The telescoping boom assembly is a contingency device, originally designed to provide a mounting location for the portable foot restraint (PFR) at the forward or aft bulkhead for the purposes of repairing or servicing the payload bay door latches. It consists of an inner and an outer tube and is 70.5 inches long from the pivot point to the end of the inner tube, which can be pulled out to extend the boom to 96 inches. Incorporated in the boom is a 900 inch-pound-rated torque limiter that will slip if the preset torque limit is exceeded. In its original application, the torque limiter was set at 450 inch-pounds to prevent damage to the bulkhead handholds.

OPERATIONAL COMMENTS

The telescoping boom mounts on the forward or aft bulkhead, clamped to the centerline or perimeter handrails. The boom may be repositioned by loosening the handrail clamp attached to the inner tube and swinging the boom about a pivot point at the other handrail clamp. This item is no longer manifested for every flight but is manifested for all inertial upper stage (IUS) flights for use as a translation aid. The foot restraint socket has been removed for IUS flights for translation ease.

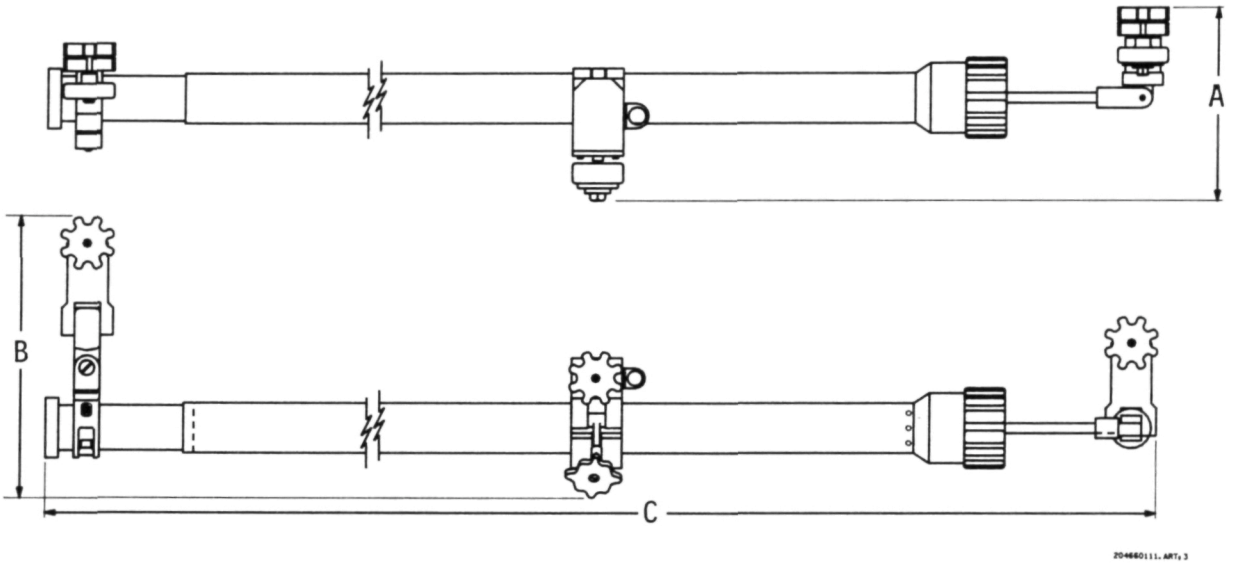
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC6, (713) 488-9247
Source: M. Withey, ILC Space Systems, (713) 488-9080

TELESCOPING BOOM

Technical Information	
Part number	10155-20003-01
Weight	11 lb
Material	Aluminum alloy, stainless steel
Availability	Flight specific

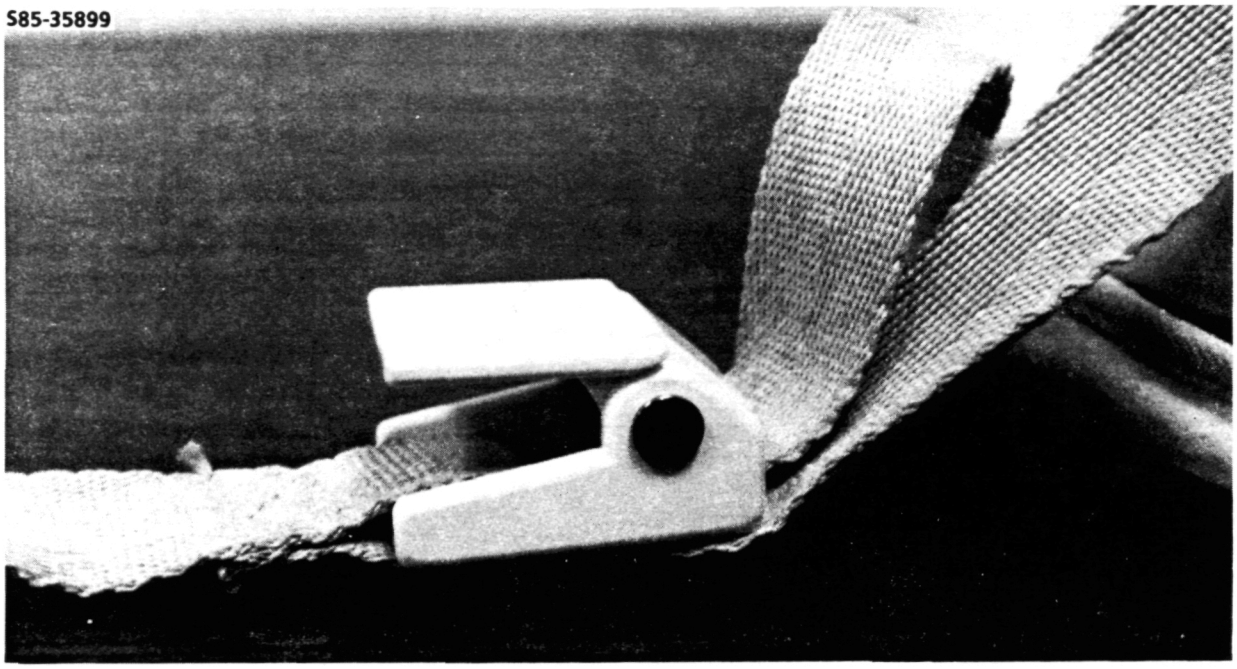
Dimensional Data	
A	7.47 in.
B	10.42 in.
C	70.32 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

TENSIONING BUCKLE

S85-35899



OVERVIEW

The tensioning buckle, also called a jam cleat, is an adjustable connector for webbing straps used to secure EVA equipment.

OPERATIONAL COMMENTS

The tensioning buckle is sewn to one end of a Kevlar strap. In operation, the end of another strap (or the other end of the same strap) is threaded through the buckle and pulled tight to secure equipment. Once the cleat is in place, pulling on the strap tightens the connection. Depressing the cleat lever releases the connection.

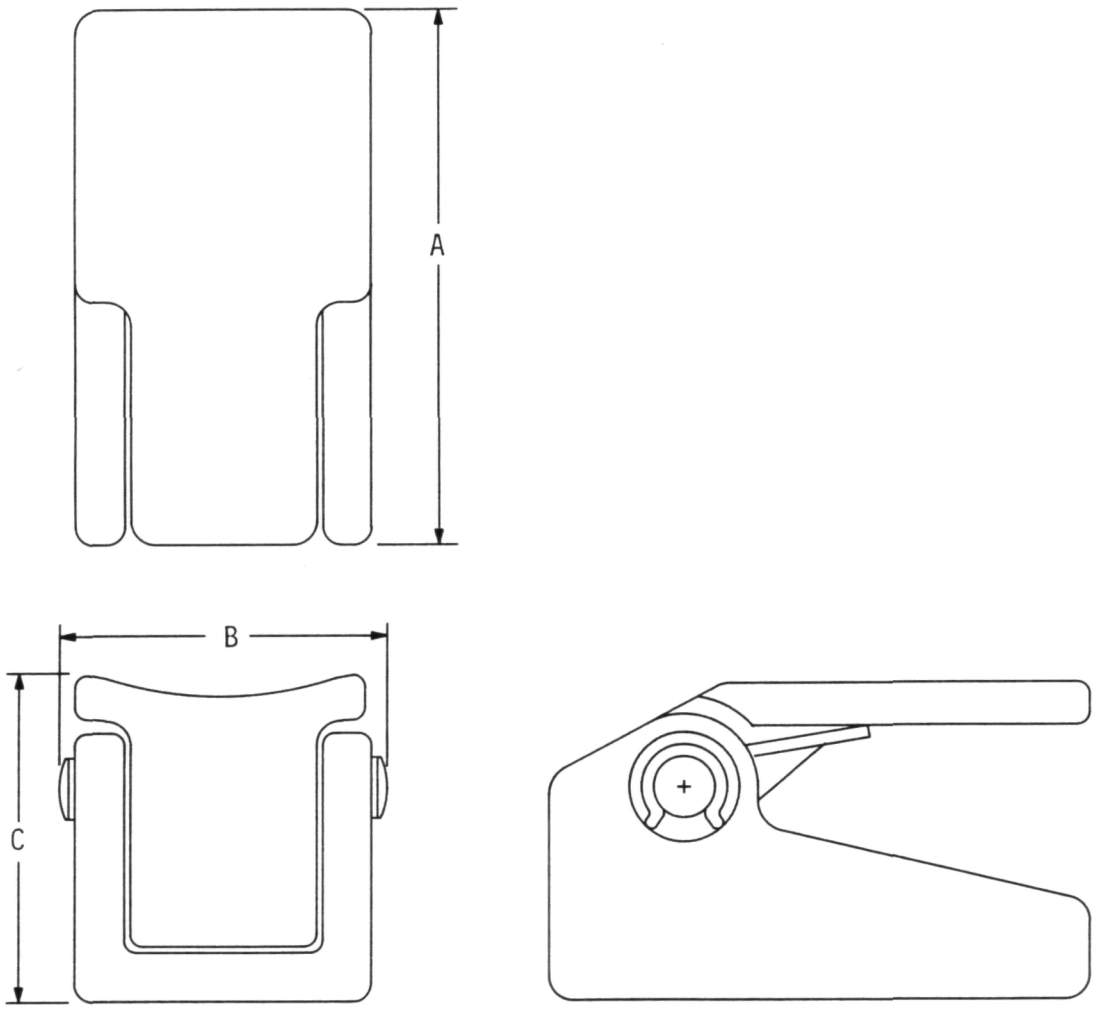
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

TENSIONING BUCKLE

Technical Information	
Part number	10174-20079-01
Weight	0.25 lb
Material	Aluminum, stainless steel
Strap width	1.0 in.
Strap thickness	0.06 in.
Quantity flown	As required
Availability	Flight specific

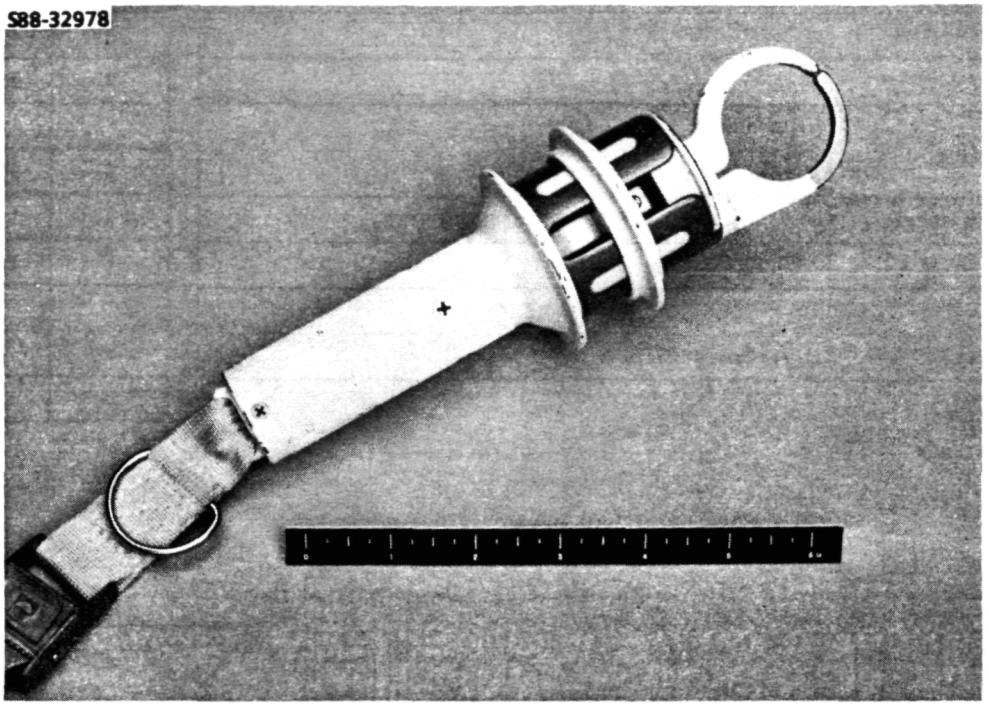
Dimensional Data	
A	1.940 in.
B	1.470 in.
C	1.103 in.



204660142.ART,1

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

TETHER HOOK, ONE-HANDED



OVERVIEW

The one-handed tether hook consists of the hook along with a strap and french hook. The hook is designed to secure tools and hardware to the EVA crewmember or to a tether point while requiring only one hand to operate the hook. This tool is currently in development.

OPERATIONAL COMMENTS

The one-handed tether hook is operated by pulling the actuating ring to open the jaws. The jaws close automatically when the actuating ring is released. An adjustable strap is attached at the base of the tether handle. The strap features a tensioning buckle for length adjustment and a french hook and D-ring for temporary restraint.

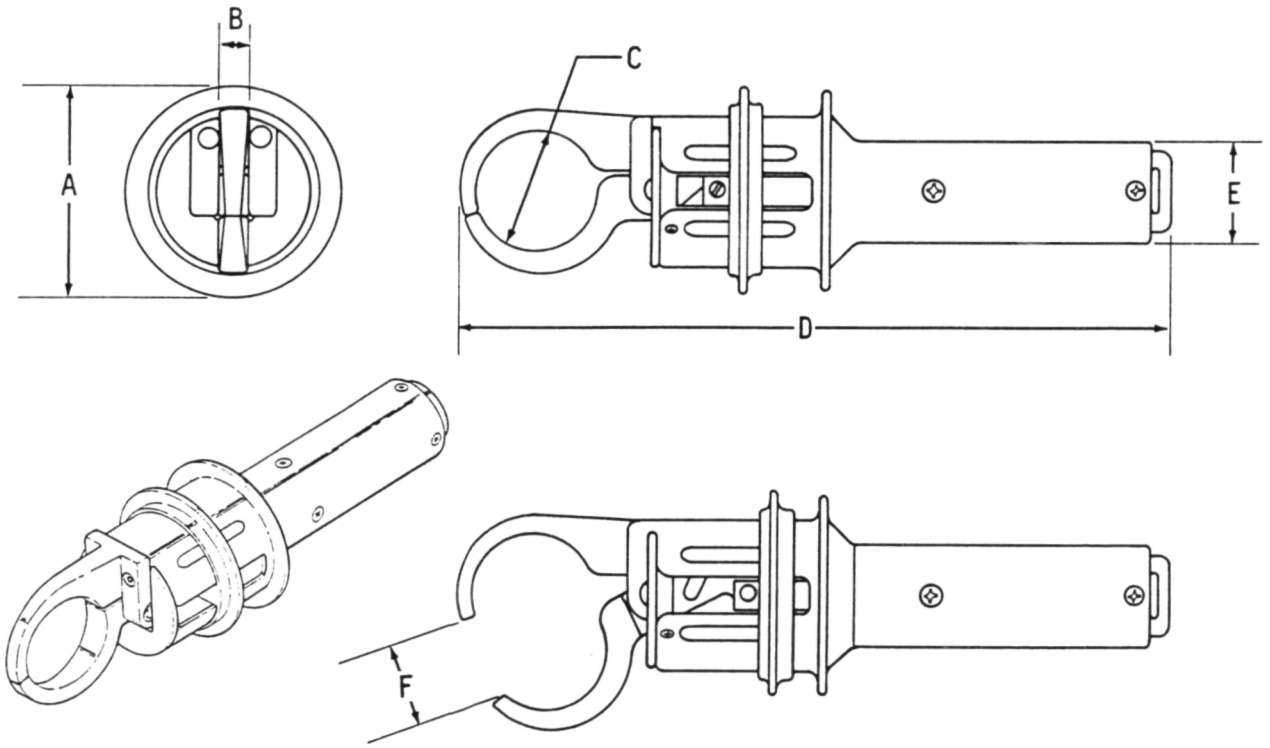
CONTACTS

Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

TETHER HOOK, ONE-HANDED

Technical Information	
Part number	10159-10050-01
Weight	TBD
Material/ construction	Aluminum Stainless steel Nomex strap
Temperature range	-150° to +250° F (operational)
Availability	Developmental

Dimensional Data	
A	2.63 in.
B	0.38 in.
C	1.50 in.
D	8.75 in.
E	1.25 in.
F	1.03 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

TETHER HOOK, QUICK ATTACH

S88-32974

OVERVIEW

The quick attach tether hook allows the crewmembers to rapidly attach and lock themselves to an EVA handrail or tether point by simply pressing the tether hook trigger against the handrail. This tool is currently in development.

OPERATIONAL COMMENTS

The hook is operated by first depressing a crossbar, located in the center of the tether hook, to place the trigger mechanism in the cocked position. A locking pin at the hook opening is retracted when the trigger mechanism is cocked. The hook is then ready to be attached to the handrail or tether point.

The hook is secured by placing the open end of the hook over a tether point and simultaneously depressing the trigger at the back of the hook opening. The locking pin is then thrust into a position that closes the hook opening and prevents the hook from inadvertently coming off the handrail. The locking mechanism can also be actuated by manually depressing a button on the back side of the hook.

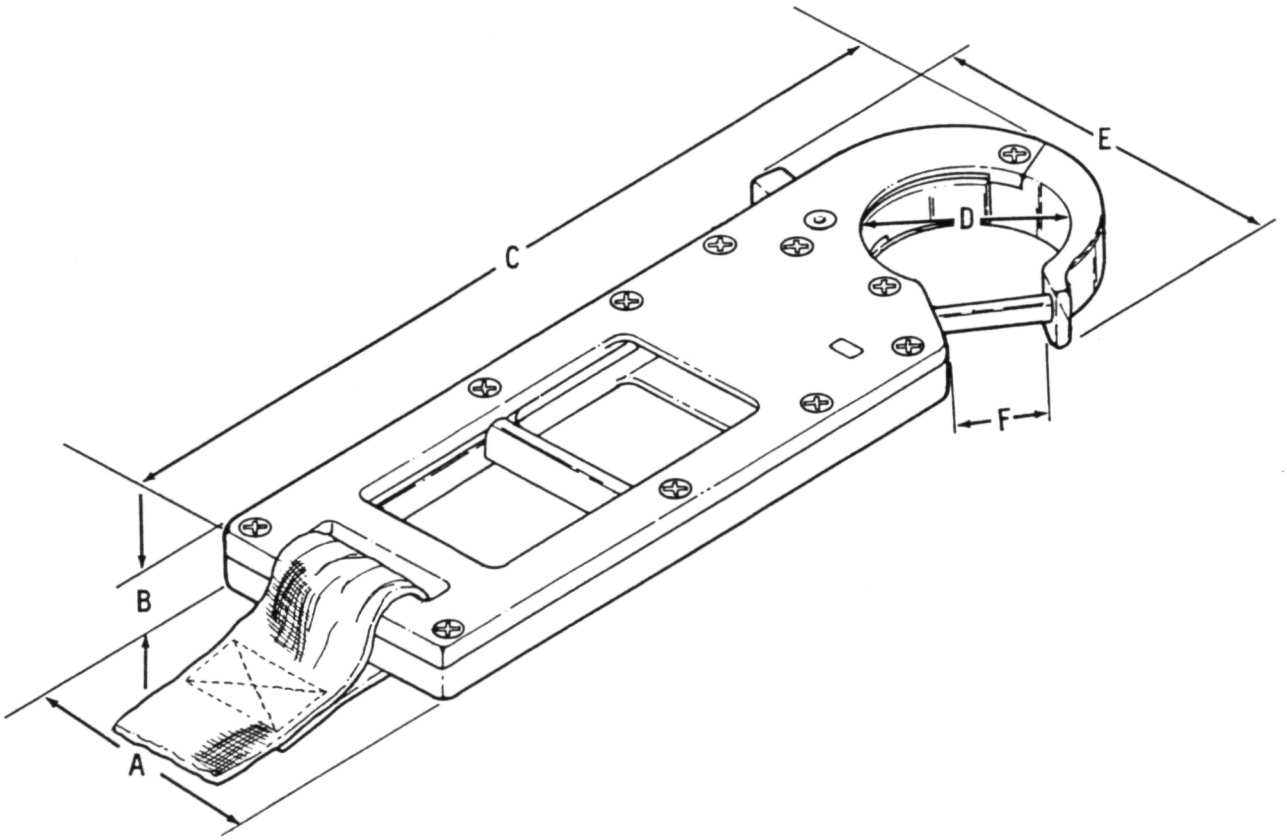
CONTACTS

Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

TETHER HOOK, QUICK ATTACH

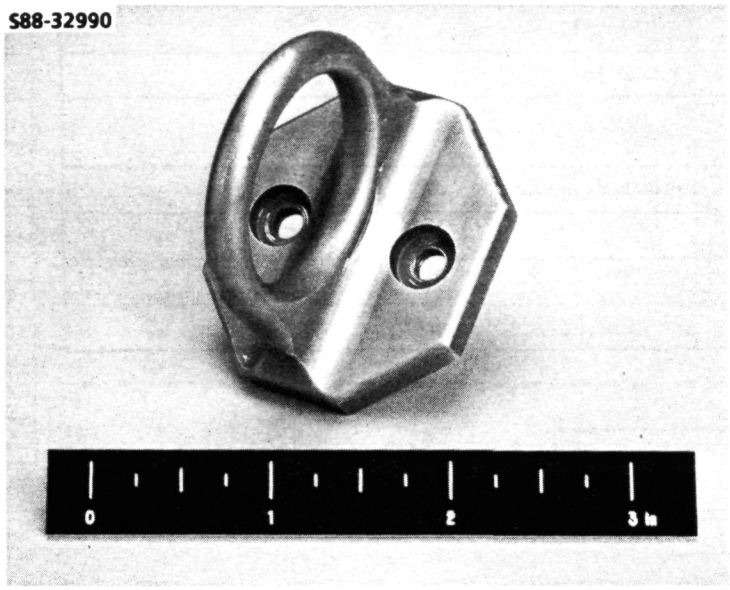
Technical Information	
Part number	10159-10051-01
Weight	0.45 lb
Material	Aluminum Stainless steel
Temperature range	-130° to +150° F (operational)
Availability	Developmental

Dimensional Data	
A	2.10 in.
B	0.5 in.
C	7.5 in.
D	1.5 in.
E	2.87 in.
F	0.90 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

TETHER POINT



OVERVIEW

The tether point, also known as a restraint eye, is available for use in a variety of EVA applications where an appropriate tether point is needed. Originally developed for the Solar Maximum Mission, the tether point was incorporated into tool boards no. 1 and no. 2.

The tether point is assembly-dependent in that it is used as a part of another assembly and is not flown as a standalone item.

OPERATIONAL COMMENTS

Each tether point is incorporated into the design of a piece of equipment depending on the need for a restraint point. The 1.25-inch internal diameter of the tether point allows for easy attachment to a large or small french hook or a large or small universal tether hook.

The strength of the tether point is determined by its intended usage. Tether points incorporated into restraint, mobility, and translation aids and those used at work stations are designed to be as strong as the waist tether and safety tether system (574-pound load limit in any direction).

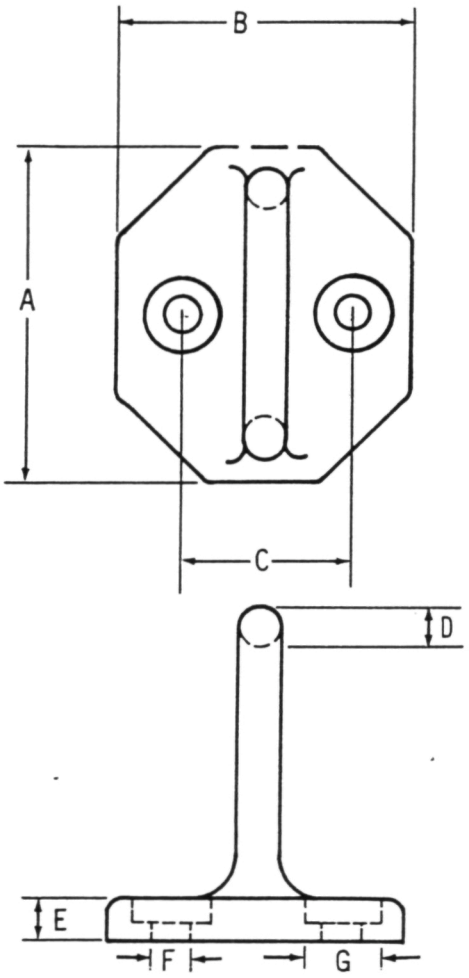
CONTACTS

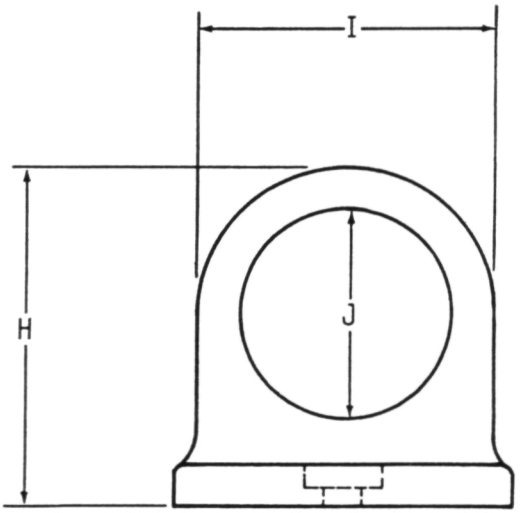
Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

TETHER POINT

Technical Information	
Part number	10174-20151-01
Weight	0.049 lb
Material/ construction	Aluminum
Temperature range	-150° to +250° F
Availability	Flight specific

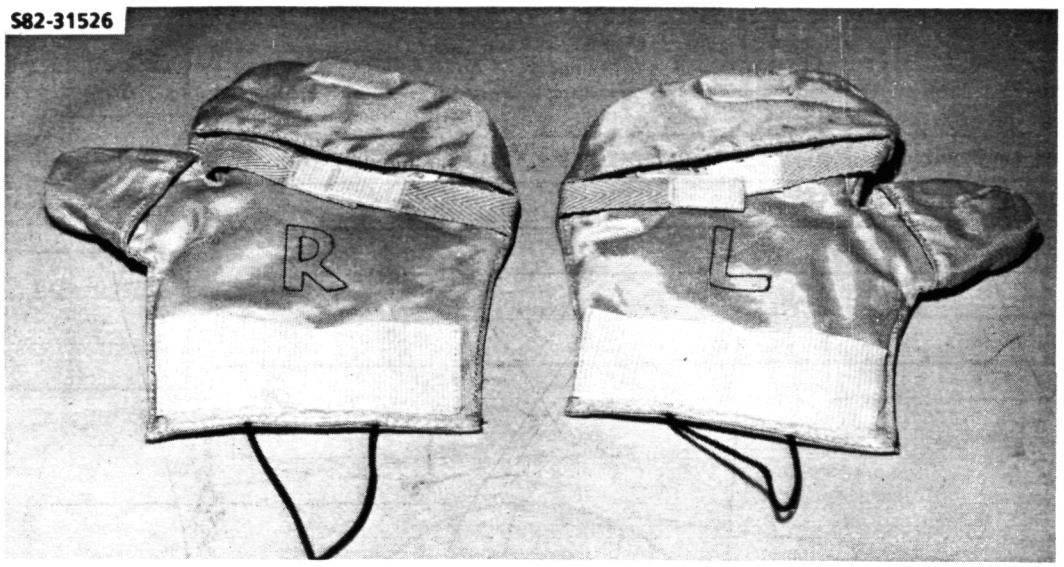
Dimensional Data	
A	2.000 in.
B	1.750 in.
C	1.000 in.
D	0.250 in.
E	0.250 in.
F	0.203 in.
G	0.406 in.
H	2.000 in.
I	1.750 in.
J	1.250 in.





ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

THERMAL MITTENS



OVERVIEW

The thermal mittens are accessories to the Space Shuttle extravehicular mobility unit (EMU) glove assemblies to allow for the handling of extremely cold or hot objects. The mittens have a main pocket for the EMU glove fingers and a side pocket for the EMU glove thumb. The thermal mittens reduce the dexterity of the EMU-gloved astronaut.

OPERATIONAL COMMENTS

A pair of thermal mittens is provided for extravehicular crewmembers who may be required to handle an object with a surface temperature lower than -180° F or higher than 235° F for longer than 30 seconds. If an object begins to feel warm when wearing the standard EMU glove, the crewmember will don the mittens. The maximum allowable surface grip temperature is 350° F. The thermal mittens are part of the normally manifested STS equipment. Two pair are stowed in the EVA bag of the middeck Volume H locker.

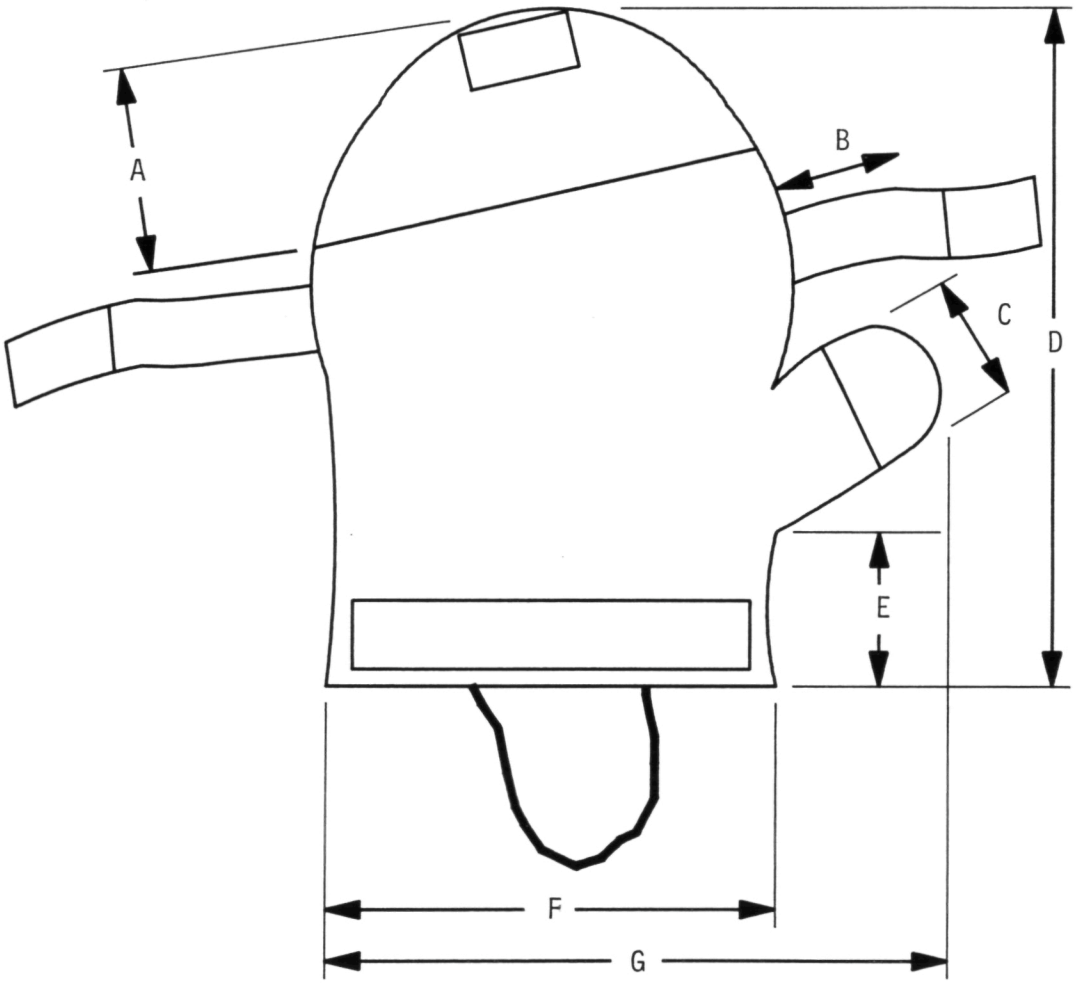
CONTACTS

Operational: C. H. Armstrong, NASA/DF42, (713) 483-2588
Technical: J. W. McBarron, NASA/EC6, (713) 483-9254
Source: J. Clougherty, ILC Dover, (302) 335-3911

THERMAL MITTENS

Technical Information	
Part number	0106-84268-05/-06/-07 left hand 0106-84268-08 right hand
Weight	0.2 lb each
Maximum temperature	350° F
Quantity flown	Two pair
Availability	Standard

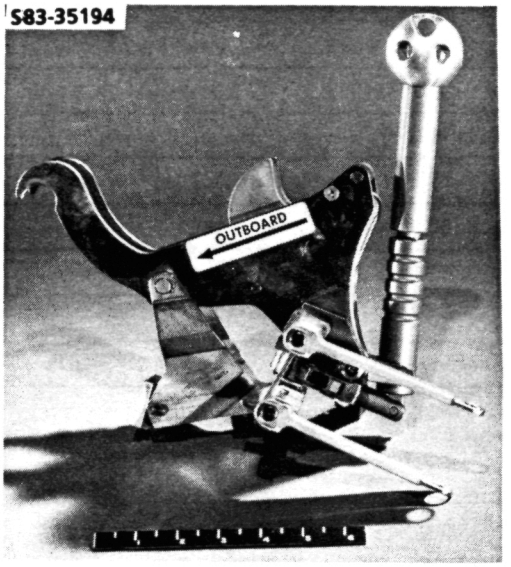
Dimensional Data	
A	3.5 in.
B	3.0 in.
C	2.0 in.
D	9.0 in.
E	2.5 in.
F	5.0 in.
G	7.0 in.



204660144.ART, 2

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

THREE-POINT LATCH TOOL



OVERVIEW

The three-point latch tool consists of one spring-loaded and two fixed-load pickup points, a reversible ratchet with stowable handle, two installation handles, and a latch. The tool duplicates the loading on a latch roller produced by a latch hook in nominal condition, transferring loads to the hook pivot, the locking bellcrank, and the latch roller, which secures the forward and aft payload bulkhead latches.

OPERATIONAL COMMENTS

The three-point latch tool is a Shuttle-unique device designed to substitute for the payload bay door forward and aft bulkhead latches if a failure occurs there. The tool cannot be installed on a bulkhead latch that has failed with the hook open less than 37° because of interference with the latch hook. Detachable installation handles allow installation of the tool on either side of the bulkhead. Presently, using the tool on the number 4 latch presents some unique cases; the operational contact should be consulted for details. This tool is part of the normally manifested STS equipment. Both three-point latch tools are stowed in the port provisions stowage assembly (PSA) in a transfer bag. New Orbiter vehicles manifest four tools until after the first two flights.

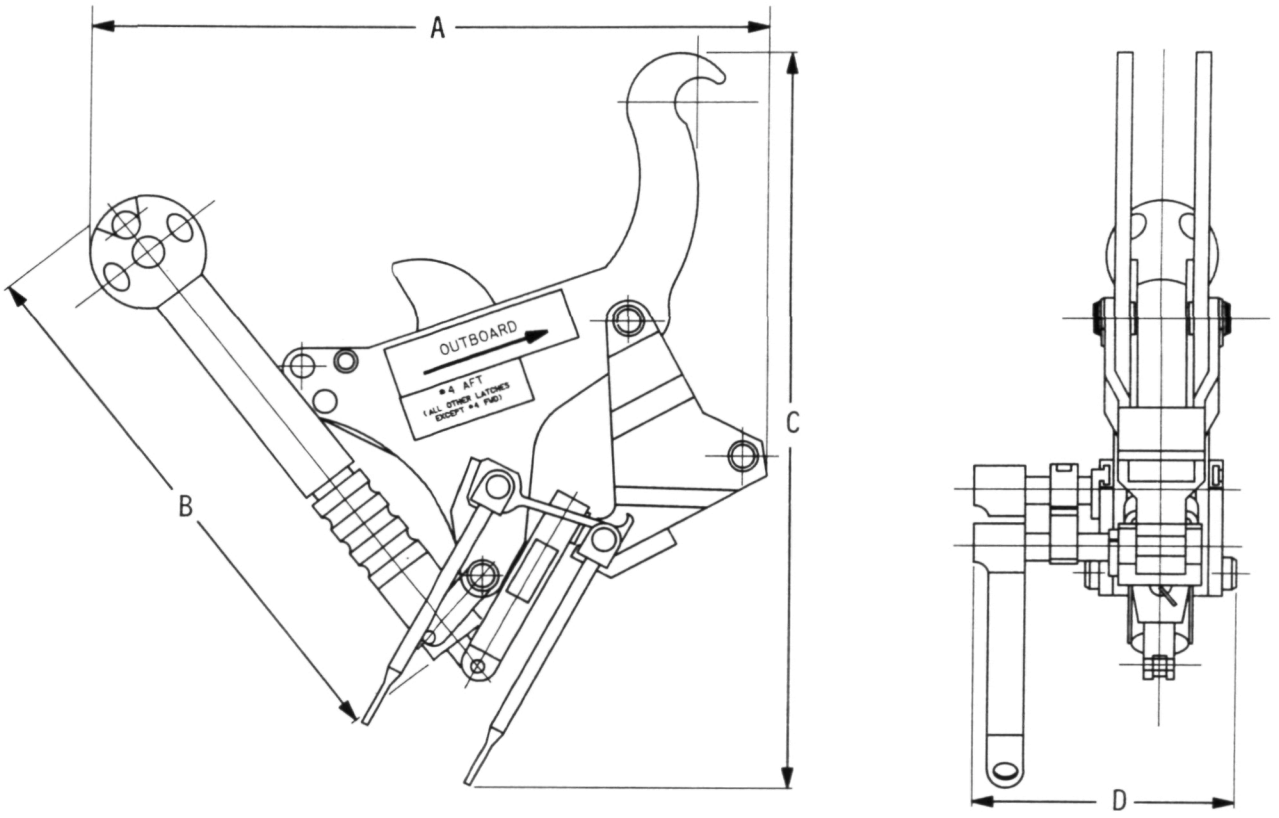
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: T. Ross, NASA/ES6, (713) 483-8941
Source: T. Ross, NASA/ES6, (713) 483-8941

THREE-POINT LATCH TOOL

Technical Information	
Part number	SED33101327-311/312
Weight	8.8 lb
Material	Stainless steel
Temperature range	-200° to 250° F (operational)
Quantity flown	Two in port PSA
Availability	Standard

Dimensional Data	
A	12.250 in.
B	9.875 in.
C	13.375 in.
D	4.560 in.



204660145.ART, 2

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

THREE-POINT LATCH TOOL BAG

OVERVIEW

The three-point latch tool bag is used to carry the latch tools from the provisions stowage assembly (PSA) to the EVA worksite. Two types of this bag exist: one with two pockets and one with four pockets, designed to hold two or four of the three-point latch tools. The bags are made of Nomex fabric and reinforced with Armalon material. Both are equipped with rings and tethers for proper restraint and tethering.

OPERATIONAL COMMENTS

The two-pocket bag is part of the normally manifested STS equipment and is stowed in the port PSA.

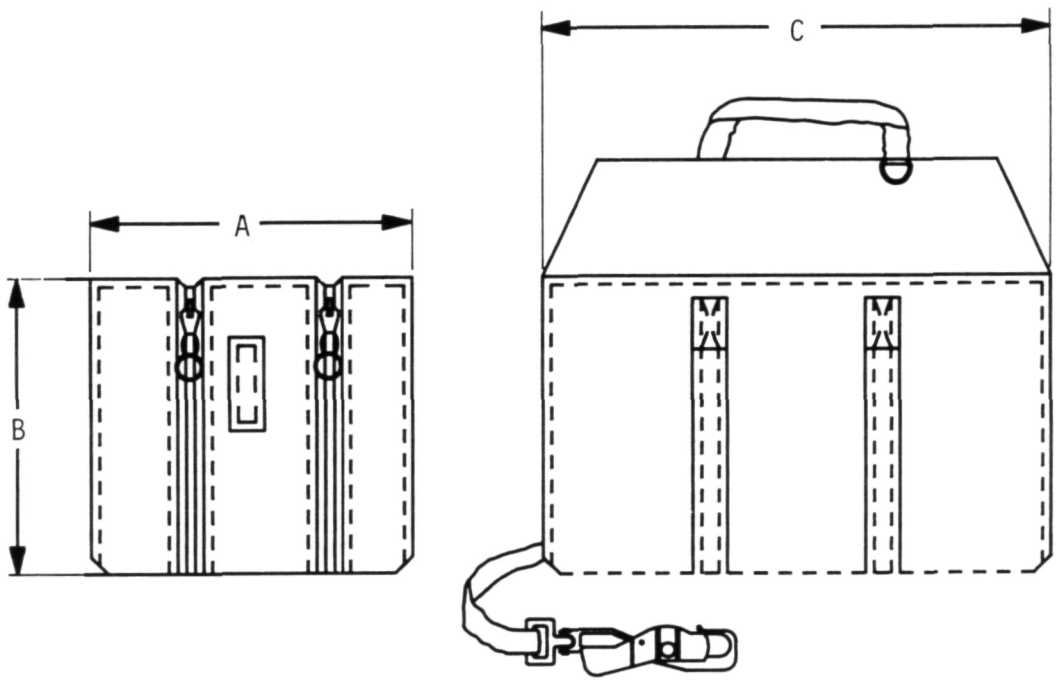
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood NASA/EC6, (713) 483-9247
Source: J. Madden, Rockwell/Houston, (713) 282-5300

THREE-POINT LATCH TOOL BAG

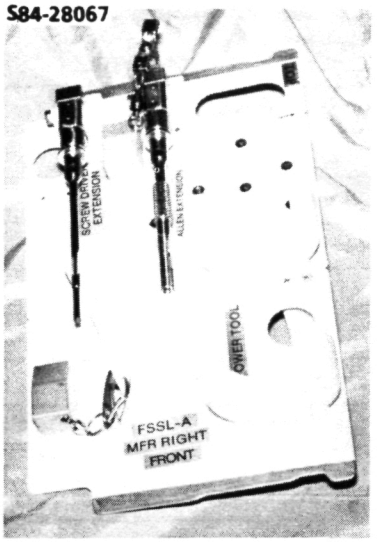
Technical Information	
Part number	V633-669300-001,-033 or SDD33103439-301 9792 (hook)
Weight	2.5 lb
Material	Fabric - Nomex, reinforced with Armalon
Temperature range	-200° to 250° F (operational)
Quantity flown	One in the port PSA
Availability	Standard

Dimensional Data	
A	10.25 in.
B	9.50 in.
C	16.25 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

TOOL BOARD



OVERVIEW

The tool board is a device used to restrain tools for stowage; it attaches to a work station stanchion or to a manipulator foot restraint (MFR) for use. The board has a tether point or points and attachments to fit each of the tools or pieces of equipment which it is to restrain. Retractable tethers with swivel hooks are provided for certain tools. Each tool attachment point is labeled.

OPERATIONAL COMMENTS

The tool board is designed to hold tools and equipment on both sides. Normally, tools can be removed or replaced with one hand using no more than 20 pounds of force. Small, similar tools such as screwdriver tips are often interchangeable in their restraint attachments for crewmember convenience. The drawing shown is a typical board layout that was used on the Solar Maximum Satellite Repair Mission. Large, plainly lettered labels are provided to identify the tools.

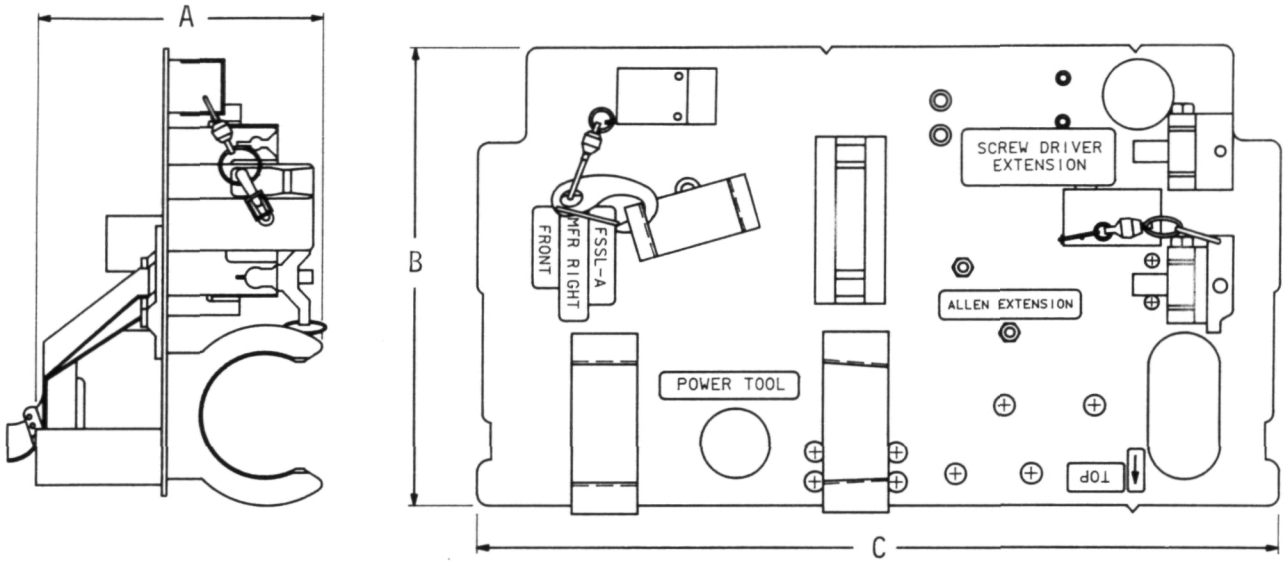
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: T. Ross, NASA/ES6, (713) 483-8941
Source: M. Withey, ILC Space Systems, (713) 488-9080

TOOL BOARD

Technical Information	
Part number	(There is no generic tool board. For a typical tool board, see SDD39117837-001)
Weight	1.0 lb (board only, without carriers)
Material	Aluminum alloy (typical)
Quantity flown	As needed
Stowage	Varies depending on intended use
Availability	Flight specific

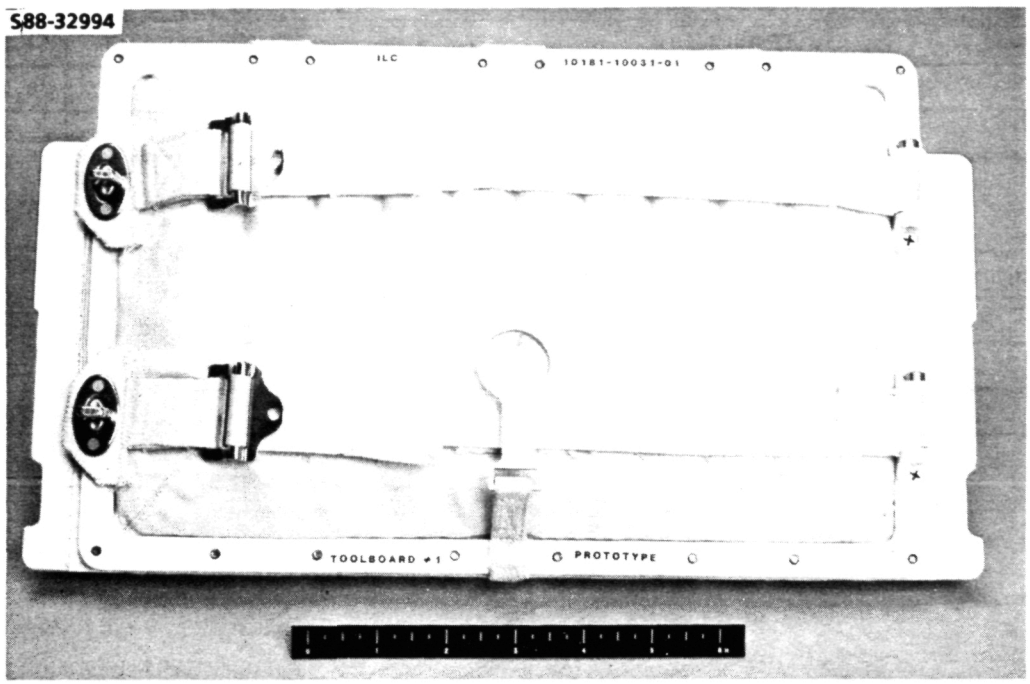
Dimensional Data	
A	4.900 in.
B	8.225 in.
C	14.357 in.



204660147.ART, 1

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

TOOL BOARD, CUSHIONED



OVERVIEW

The cushioned tool board is designed to restrain Hubble Space Telescope (HST) tools not dedicated to other stowage locations. The tool board consists of two cushioned sides with retention straps to hold the tools against the cushions. A tether ring is provided for transfer of the tool board.

OPERATIONAL COMMENTS

To stow or release tools to/from the toolboard, the 1/4-turn fastener at the end of the straps is used. The straps have adjusters to allow for proper retention of various sizes of tools.

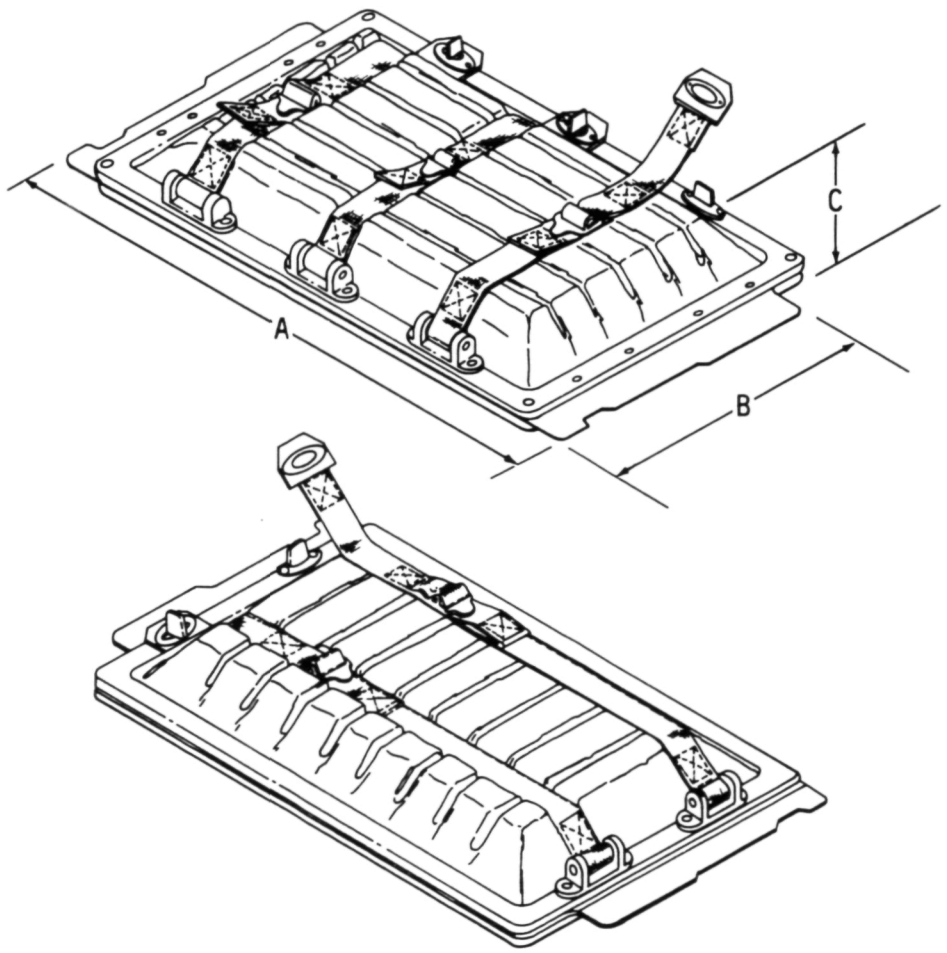
CONTACTS

Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

TOOL BOARD, CUSHIONED

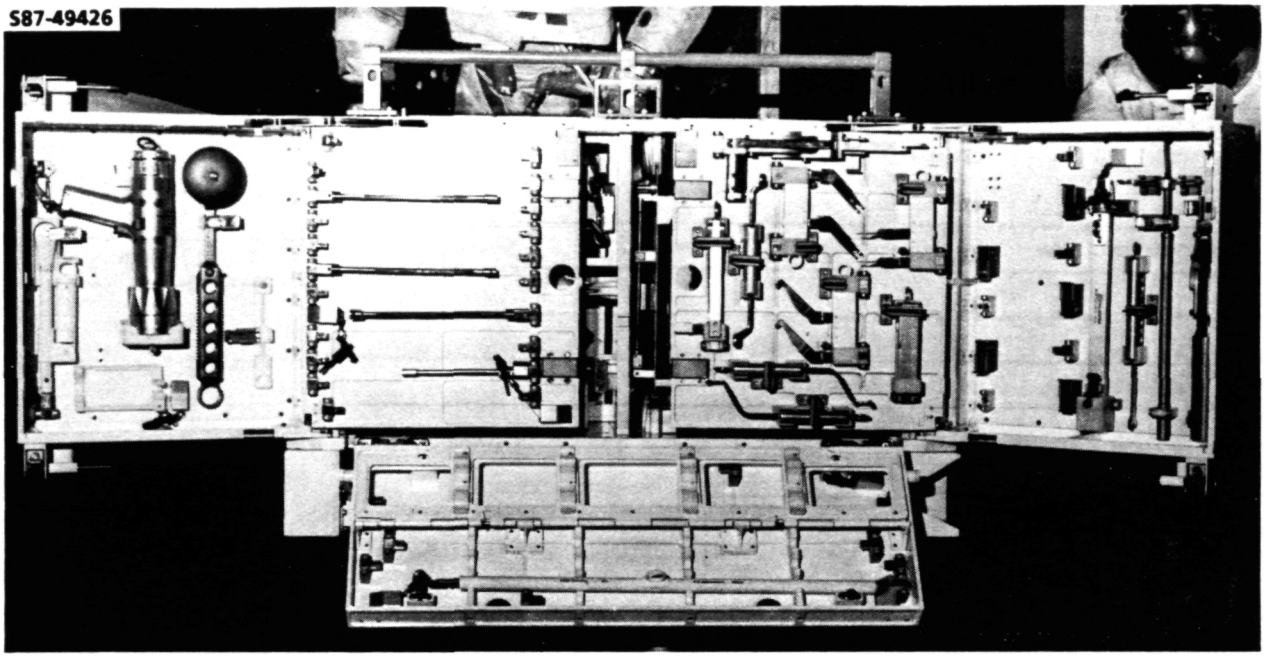
Technical Information	
Part number	10181-10031-01
Weight	2.49 lb
Material/ construction	Aluminum Nomex webbing and fabric Solamide foam 1/4-turn fasteners Adjustment buckles
Temperature range	-150° to +250° F (operational)
Availability	Flight specific

Dimensional Data	
A	14.32 in.
B	8.06 in.
C	2.89 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

TOOL BOX (HST)



OVERVIEW

The Hubble Space Telescope (HST) tool box provides stowage of individual tools, tool boards, and tool caddies required for the maintenance and repair of the HST. The basic box design was derived from the Leasat equipment stowage container. It can be mounted to a baseplate or backplate depending on the mission location requirements. A four-point latching system secured with pip pins is employed to latch the tool box doors for launch. Various other latches are designed into the door panels and tool mounting locations for tool retention.

OPERATIONAL COMMENTS

The HST tool box consists of aluminum sides and base, a dividing wall, and deep doors. Along three sides there are handrails by which EVA crewmembers can translate themselves or brace themselves when stowing and unstowing equipment. The tool box interior accommodates tool boards, tool caddies, and individual tools and equipment. The tool box doors are designed with sufficient depth to allow storage on the front and back of the swing-out door panels. The inside door skins also have provisions for tool mounting.

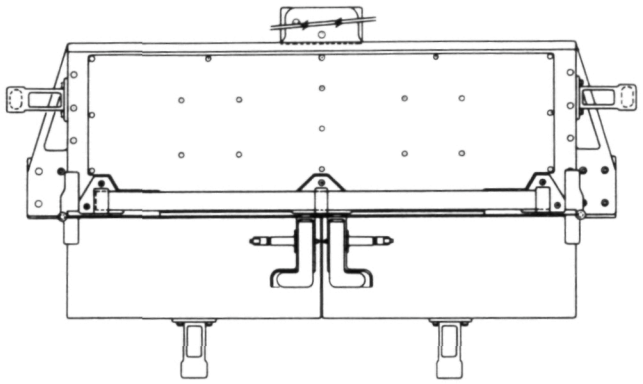
CONTACTS

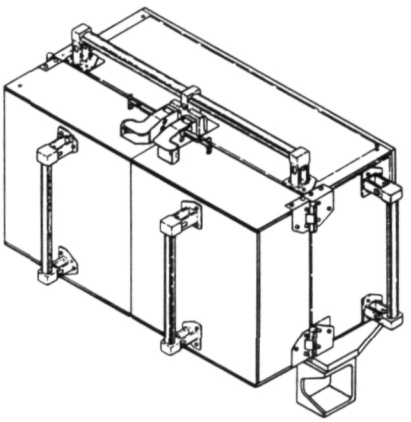
Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

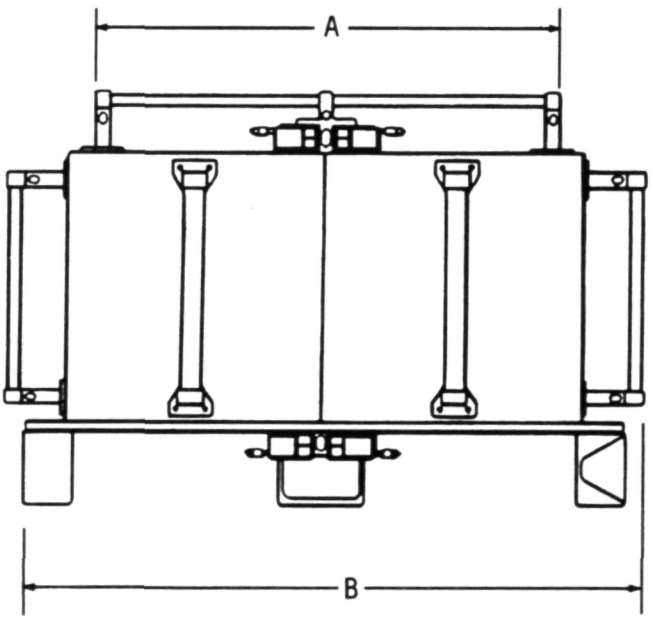
TOOL BOX (HST)

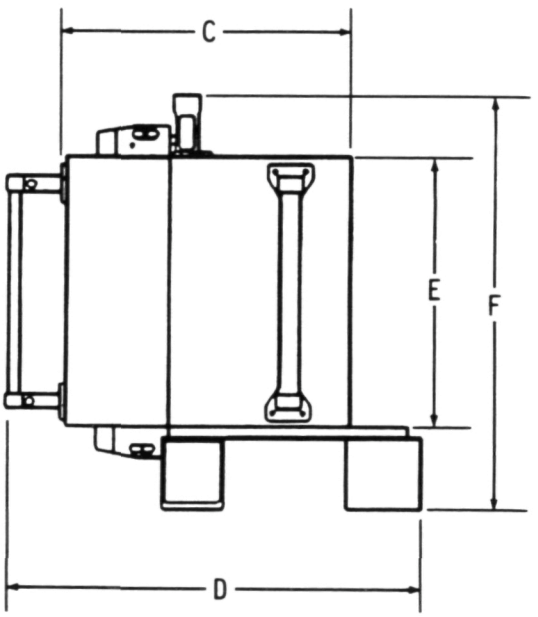
Technical Information	
Part number	10181-10030-1
Weight	190.0 lb
Material/ construction	Aluminum Stainless steel Aluminum bronze Delrin
Temperature range	-150° to +250° F (operational)
Availability	Flight specific

Dimensional Data	
A	34.56 in.
B	42.70 in.
C	19.00 in.
D	26.97 in.
E	18.75 in.
F	28.60 in.



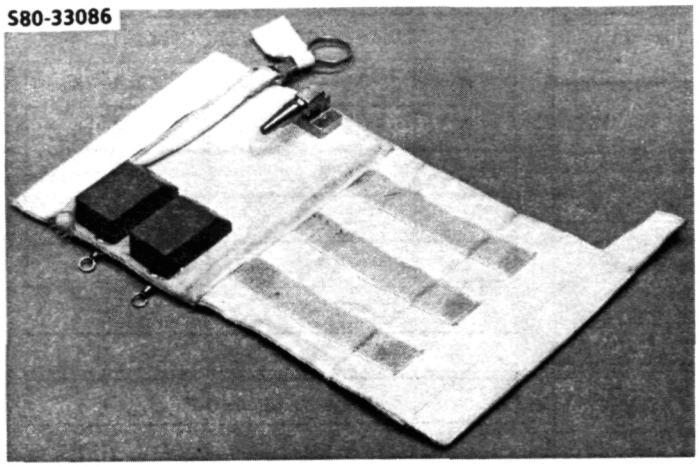


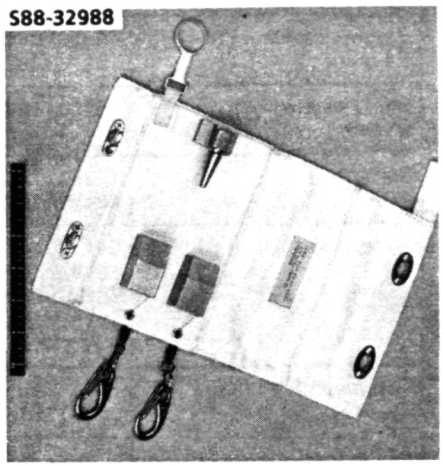




ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

TOOL CADDY





OVERVIEW

The tool caddy is a stiffened fabric container for storing tools for EVA use. The tool caddy serves three purposes: the stowage of EVA tools, the transfer of tools to the worksite, and the tethering of tools at the worksite.

OPERATIONAL COMMENTS

The original tool caddies (10153-10053-01/-02/-03/-04 and 10176-20269-01/-02) consist of an 8- by 13-inch piece of stiffened fabric which folds over the tools, closes, and seals with Velcro; a tether tab with a 1-inch ring; an interface adapter which attaches to a receptacle on the mini work station; and two split-ring-and-swivel attachments on 3- or 6-foot retracting tethers. The split rings and swivels attach a maximum of two tools to each caddy, and four caddies can be attached to one mini work station simultaneously. The tools are held in place by mating hook Velcro on the tools with pile Velcro on the caddy surface. When these caddies are folded, they measure 8 by 6.5 inches. Hook Velcro on a tool has proven to be abrasive to the extravehicular mobility unit (EMU) glove palms.

A second style of caddy has been developed which does not use Velcro as a method of tool retention. These caddies (10181-10044-01/-02) consist of stiffened fabric which folds over the tools, closes, and is sealed by use of a 1/4-turn fastener; an interface adapter bracket and tether ring for attachment to the mini work station or a similar receptacle; and two 2-inch french hooks on individual 6-foot retracting tethers, which are used to tether a maximum of two tools to each caddy. When these caddies are folded, they measure 9 by 4-3/4 inches.

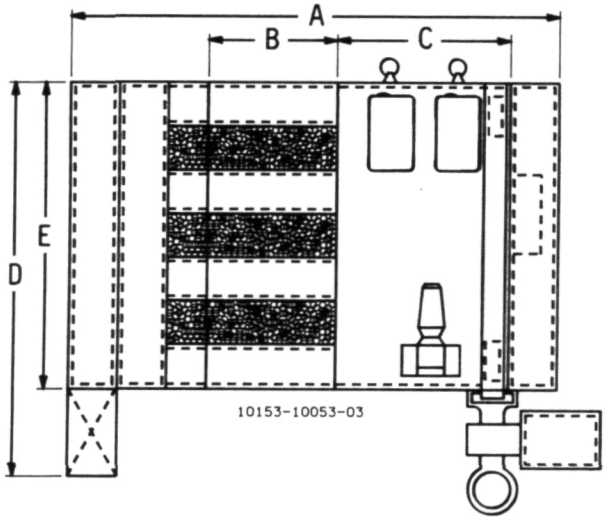
CONTACTS

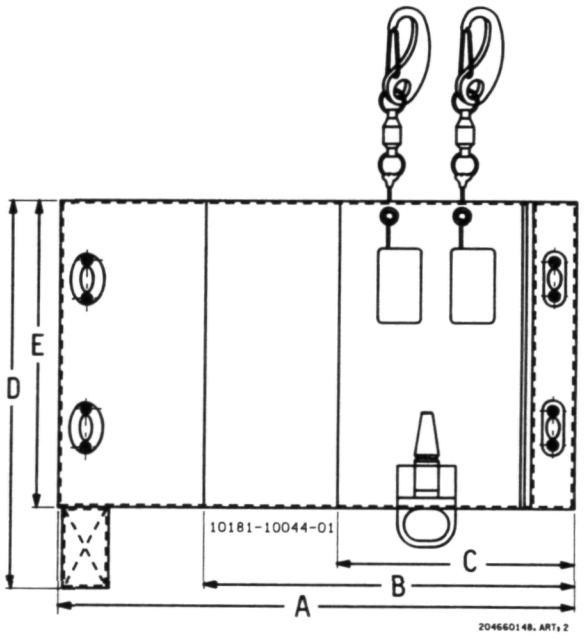
Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: M. Withey, ILC Space Systems, (713) 488-9080

TOOL CADDY

Technical Information	
Part number with Velcro	10153-10053-01/-02/-03/-04 10176-20269-01/-02
Part number without Velcro	10181-10044-01/-02
Weight	10153-10053-03 - 0.77 lb 10181-10044-01 - 1.8 lb
Material	Stiffened fabric 10153-10053 - pile Velcro 10176-20269 - pile Velcro 10181-10044 - stainless steel fastener
Temperature range	-130° to + 150° F (10153 and 10176) -150° to + 250° F (10181)
Quantity flown	As required
Stowage	Varies depending on use
Availability	10153-10053 - standard 10176-20269 - flight specific 10181-10044 - flight specific

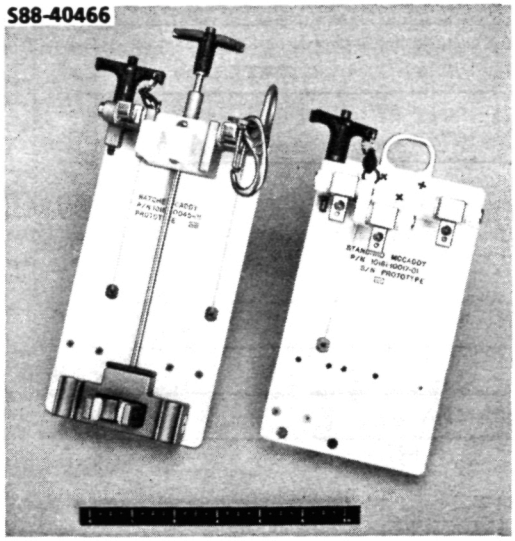
Dimensional Data		
	10153-10053-03	10181-10044
A	11.4 in.	12.1 in.
B	3.8 in.	8.6 in.
C	4.3 in.	5.5 in.
D	8.8 in.	9.1 in.
E	7.0 in.	7.2 in.





ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

TOOL CADDY, McCADDY AND RATCHET



OVERVIEW

The McCaddy and ratchet caddy assemblies are similar in design to small tool boards for storing, transporting, and tethering tools for EVA use. They were created for Hubble Space Telescope (HST) maintenance applications. The McCaddy is designed to accommodate three drop-proof tether socketed tools. The ratchet caddy accommodates two drop-proof tether tools and one 3/8-inch drive McTether ratchet. The ratchet is secured by two hardpoint locking mechanisms and is tethered by use of a 6-foot retracting tether with a small french hook.

OPERATIONAL COMMENTS

A pip pin attached to a self-retracting tether is included for easy removal or installation of the tools. The self-retracting tether is positioned on the backside of the caddy, allowing the tether cord to be positioned at an angle minimizing abrasion on the tether cord. A bayonet fitting on each caddy allows for attachment to the mini work station. A tether ring provides for safe transfer of the caddy to and from stowage sites.

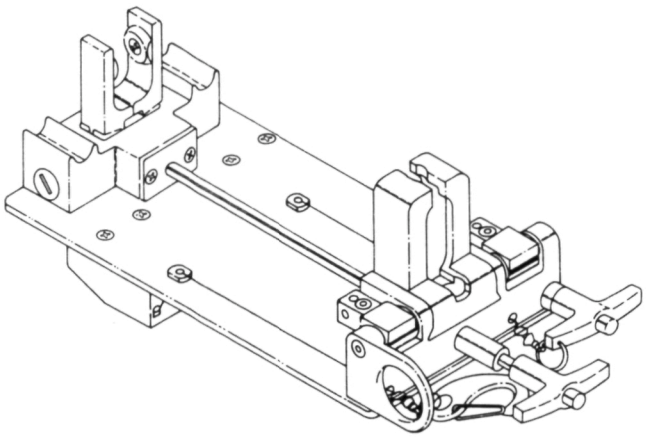
CONTACTS

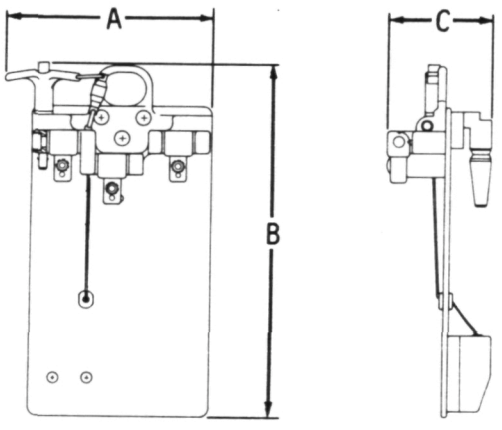
Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

TOOL CADDY, McCADDY AND RATCHET

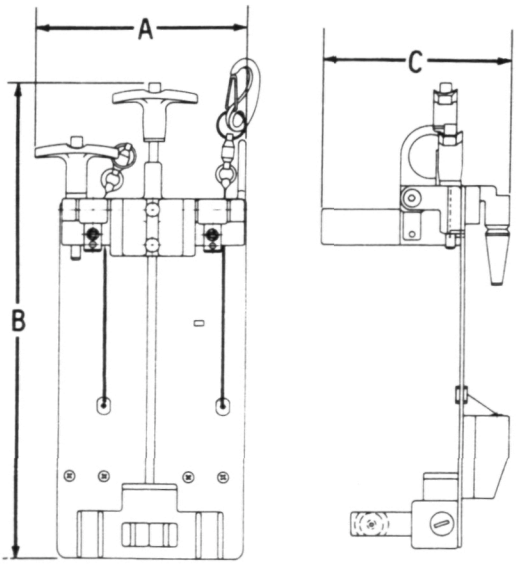
Technical Information	
Part number	10181-10017-01 - standard McCaddy 10181-10045-01 - ratchet caddy
Weight	10181-10017-01 1.50 lb 10181-10045-01 1.95 lb
Material/ construction	Aluminum Delrin Stainless steel
Temperature range	-150° to +250° F
Availability	Flight specific

Dimensional Data		
	10045-01	10017-01
A	4.55 in.	5.200 in.
B	10.20 in.	7.933 in.
C	4.00 in.	2.290 in.





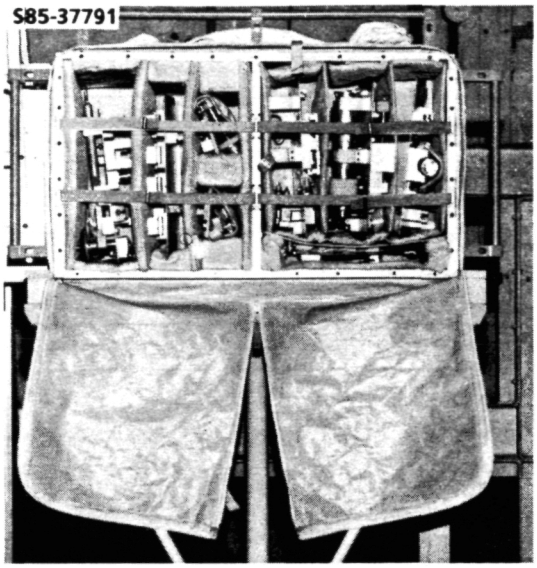
10181-10017-01



10181-10045-01

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

TOOL CONTAINER ASSEMBLY



OVERVIEW

The tool container assembly (TCA) provides stowage of tool boards and tool caddies with tools and equipment attached. This item is currently an integral part of the Leasat equipment stowage assembly (LESA).

OPERATIONAL COMMENTS

The TCA has an aluminum top, sides, base, and central wall. Fabric-covered foam partitions are individually sized to enclose each tool board or caddy. Handrails are provided along the edges of the TCA. The front of the TCA has zippered fabric covers which secure the boards and caddies in their positions and allow a suited crewmember one-handed operation in removing or replacing necessary tool boards or caddies. Kevlar retainer straps restrain TCA contents when the fabric cover is open. Devices are provided on the TCA for attachment of the EVA trash bags during entry and of transfer bags during salvage operations. The TCA contained five tool boards and three tool caddies on STS 51-I.

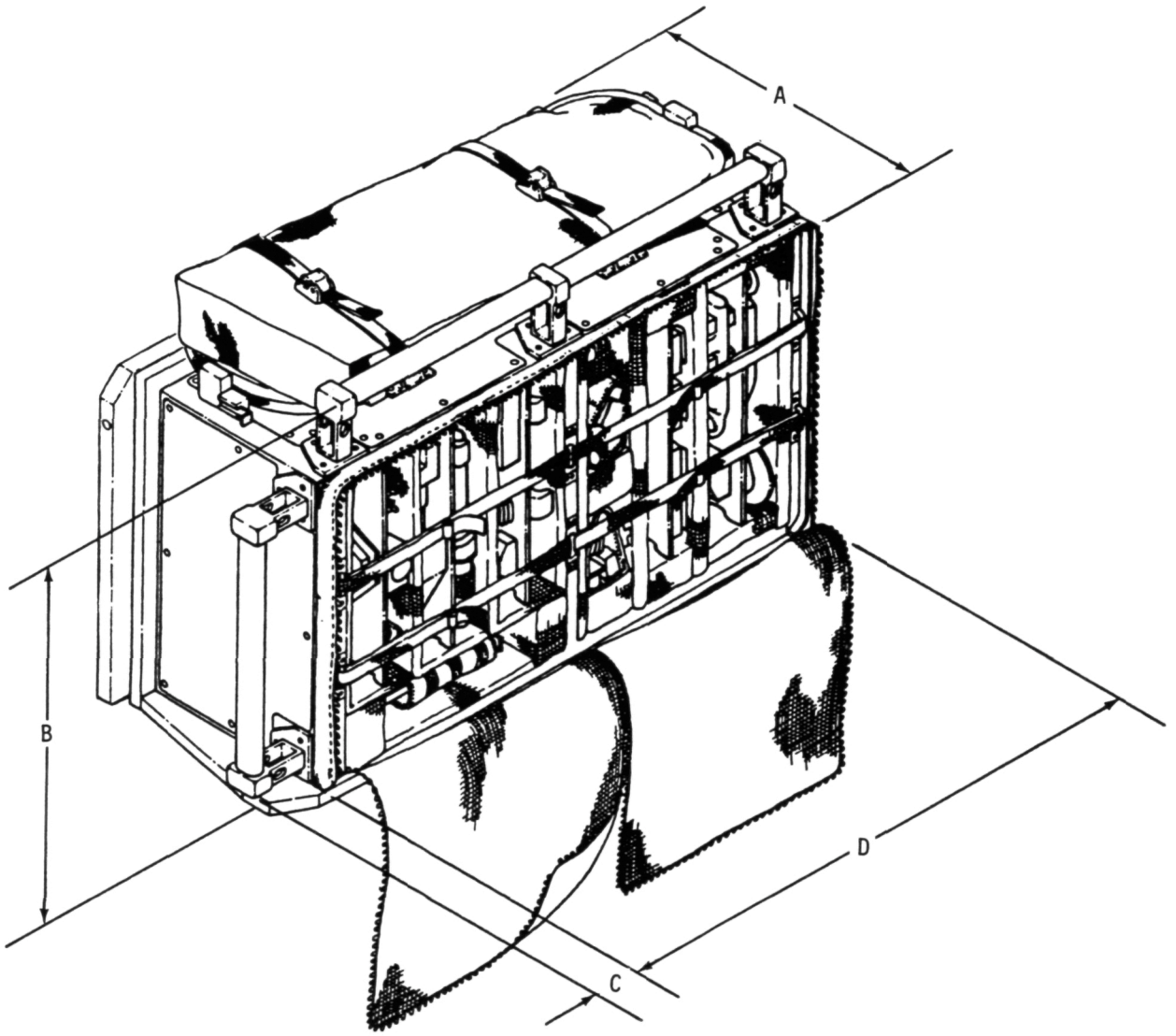
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

TOOL CONTAINER ASSEMBLY

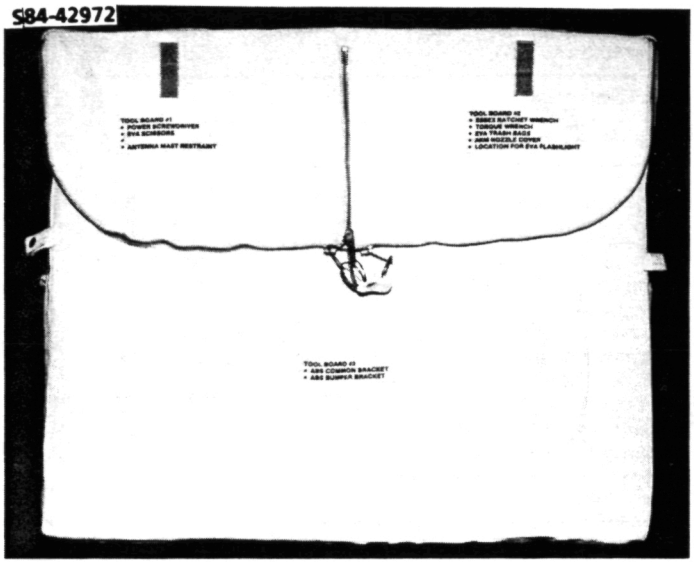
Technical Information	
Part number	10176-20003-01
Weight	99.0 lb
Material	Aluminum, Solemide foam, Nomex fabric, Armalon
Stowage	Bay no. 3, starboard on STS 51-I
Availability	Flight specific

Dimensional Data	
A	15.875 in.
B	23.600 in.
C	4.100 in.
D	34.500 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

TOOL STOWAGE BAG



OVERVIEW

The tool stowage bag, also called the equipment stowage container, stows and protects EVA tool boards and tools used during repair operations on Westar/Palapa-type satellites.

OPERATIONAL COMMENTS

The tool stowage bag is fabricated from Ortho and Armalon fabrics with two major zippered openings through which the tool boards can be accessed. The fabric top and sides are supported by an aluminum base, which is bolted into stowage position in the cargo bay. Fabric-covered Solemide foam dividers act as bumpers between tools and tool boards. All zipper pulls have ring tabs to allow the EVA crewmember easy operation with gloved hands.

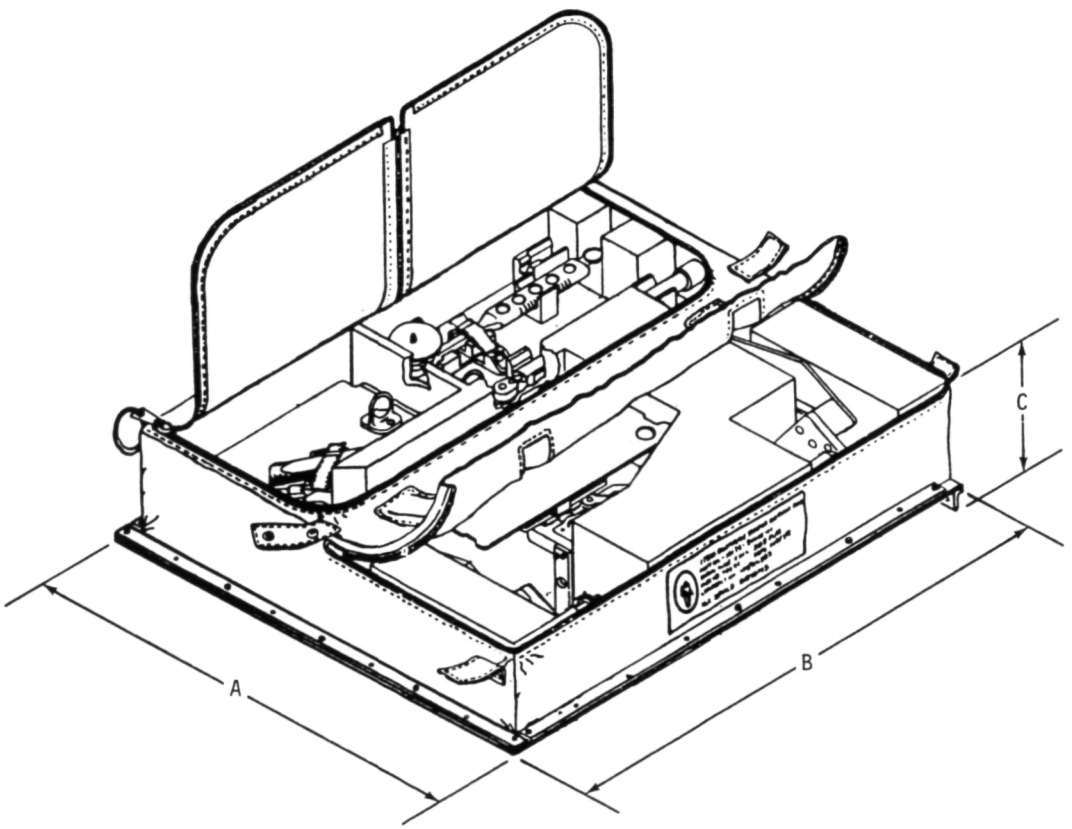
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

TOOL STOWAGE BAG

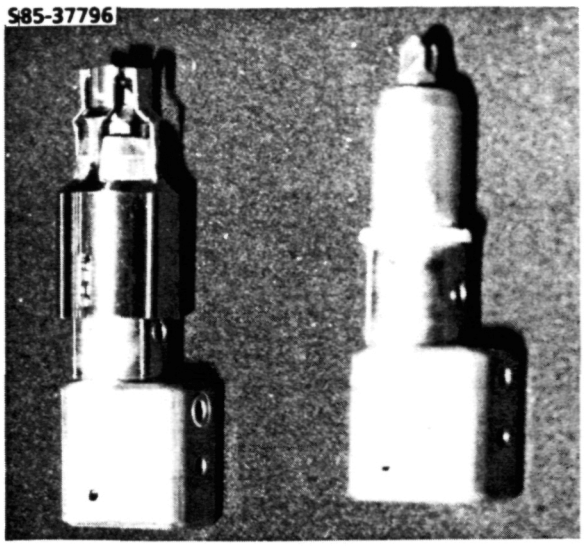
Technical Information	
Part number	10174-20085-01
Weight	63.5 lb loaded
Material	Ortho, Armalon
Contents of stowage container:	
Tool board #1	Power screwdriver, EVA scissors, antenna mast restraint
Tool board #2	EVA 3/8-in. drive ratchet wrench, torque wrench, EVA trash bags, apogee kick motor nozzle cover, EVA flashlight
Tool board #3	Antenna bridge structure (ABS) common bracket, ABS bumper bracket
Stowage	Cargo bay
Availability	Flight specific

Dimensional Data	
A	27.75 in.
B	31.75 in.
C	7.50 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

TORQ-SET TIP EXTENSION



OVERVIEW

The Torq-Set tips modified for EVA use are number 8 and number 10 size tips. Both sizes have drop-proof tether attachments and capture devices to hold Torq-Set screws. Another version of the number 8 tip has no capture device.

OPERATIONAL COMMENTS

Two number 8 tips without capture devices and two number 10 tips with capture devices were successfully used on STS 51-I, the Leasat Salvage Mission.

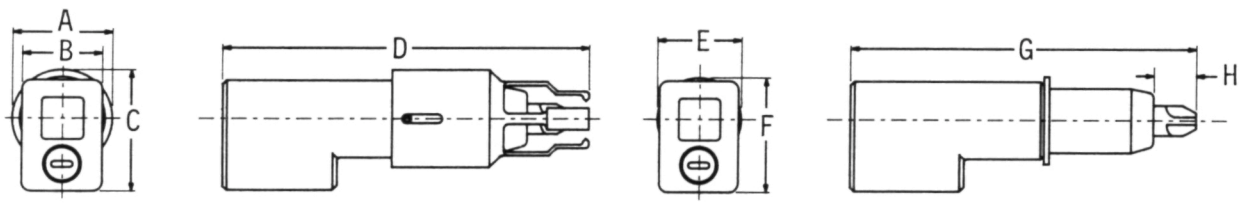
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

TORQ-SET TIP EXTENSION

Technical Information	
Part number	
No. 8 with capture device	10176-20132-01
No. 8 without capture device	10176-20132-02
No. 10 with capture device	10176-20135-01
Quantity flown	Two each on STS 51-I
Stowage	Tool board
Availability	Flight specific

Dimensional Data	
A	0.875 in.
B	0.007 in.
C	1.100 in.
D	3.228 in.
E	0.257 in.
F	1.025 in.
G	3.120 in.
H	0.810 in.



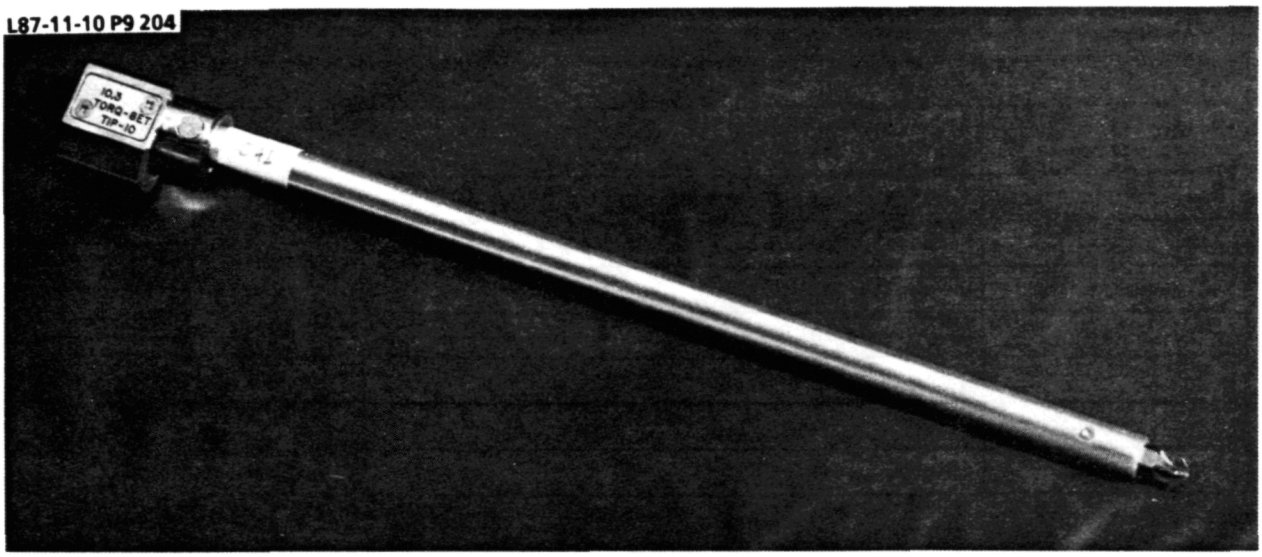
10176-20132-01

10176-20132-02

204660169. ART. 3

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

TORQ-SET TIP EXTENSION (HST)



OVERVIEW

The number 10 Torq-Set tip tool is sized to fit a number 10 Torq-Set screw. The tip is extended on a 9-inch shaft with a 3/8-inch drive drop-proof tether.

OPERATIONAL COMMENTS

The Torq-Set tip is used to loosen or tighten Torq-Set screws. It is a contingency tool used as a backup release tool for Hubble Space Telescope (HST) 5/16-inch and 7/16-inch captive hex-head screws or for use where there is insufficient clearance for a socket.

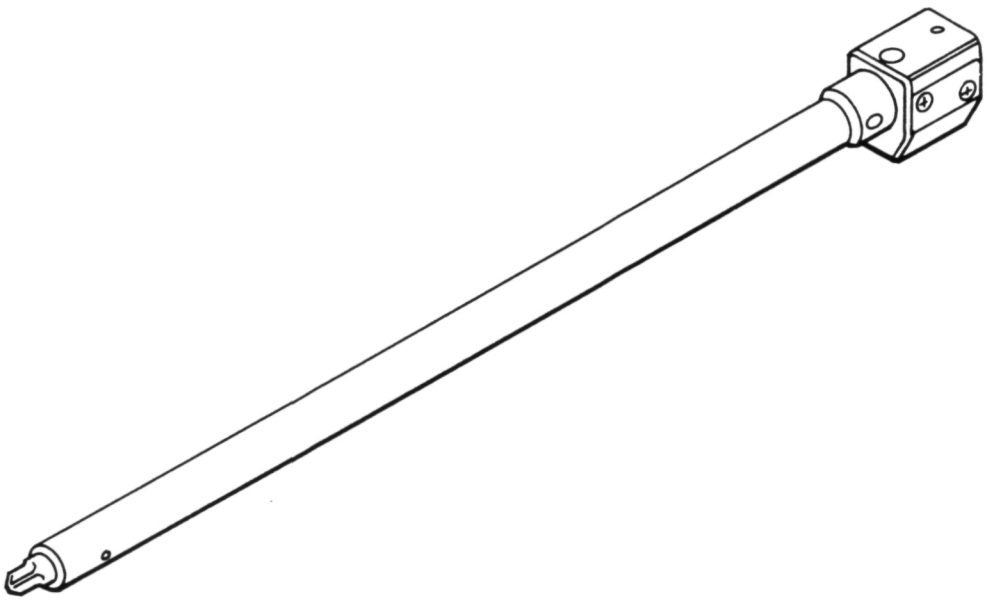
CONTACTS

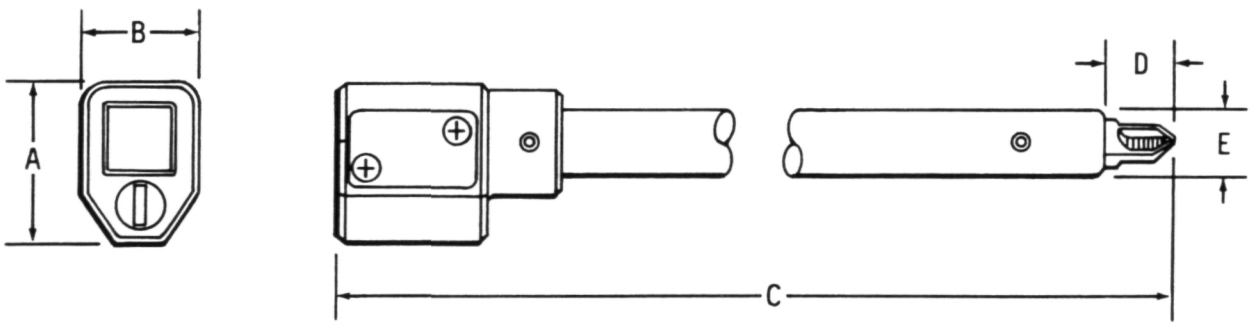
Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

TORQUE-SET TIP EXTENSION (HST)

Technical Information	
Part number	10181-10021-01
Weight	0.22 lb
Material/ construction	Aluminum Stainless steel
Temperature range	-150° to +250° F (operational)
Tip	Number 10 Torq-Set serrated tip
Alignment marks	On shaft
Force/torque	84.0 in-lb
Availability	Flight specific

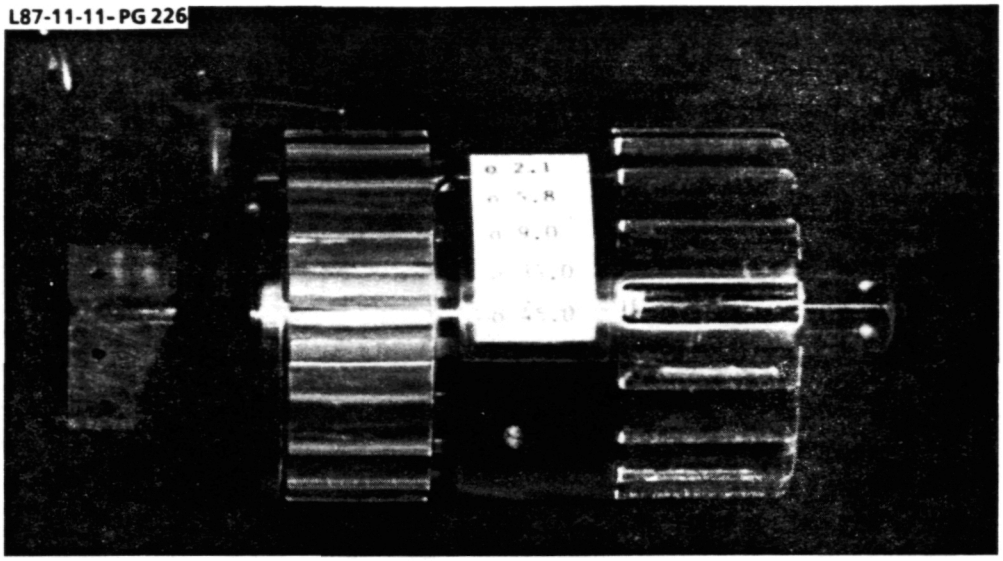
Dimensional Data	
A	0.920 in.
B	0.660 in.
C	10.320 in.
D	0.600 in.
E	0.375 in.





ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

TORQUE LIMITER, MULTISETTING



OVERVIEW

The multisetting torque limiter was created for Hubble Space Telescope (HST) maintenance and incorporates five different torque limit ranges: 1.7 to 2.1, 4.8 to 5.8, 7.5 to 9.0, 32 to 35, and 40 to 45 foot-pounds. These five different torque limit ranges are marked as 2.0, 5.3, 9.0, 35, and 45 foot-pounds on the torque limiter. They are designed to limit torque in both clockwise and counterclockwise directions. The removal (counter-clockwise) torque is approximately 10 percent higher than the tightening (clockwise) torque. The torque limiter interfaces with any 3/8-inch drive and has a drop-proof tether.

OPERATIONAL COMMENTS

The torque limiter is designed to prevent the over-torquing of fasteners in clockwise and counterclockwise directions. When torque is applied, the limiter will indicate that the torque limit has been reached by a slippage of approximately 30° at the socket drive end without further torque increase. The limiter will reset to deliver torque within 45° from the original start of slippage. A sliding lock button prevents accidental changes in the desired torque setting.

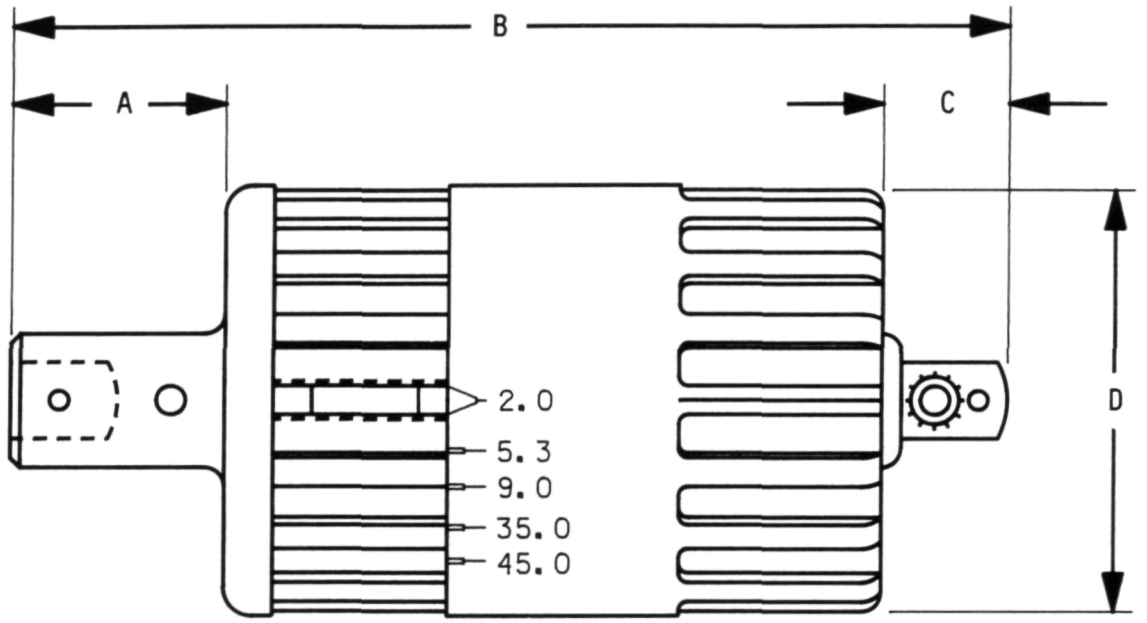
CONTACTS

Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. Sheffield, LMSC/Dept 64-10, (408) 742-8464
Source: E. Pruiett, Essex Corp., (408) 742-8464

TORQUE LIMITER, MULTISETTING

Technical Information	
Part number	4177657-001
Weight	2.5 lb
Material	Stainless steel
Availability	Flight specific

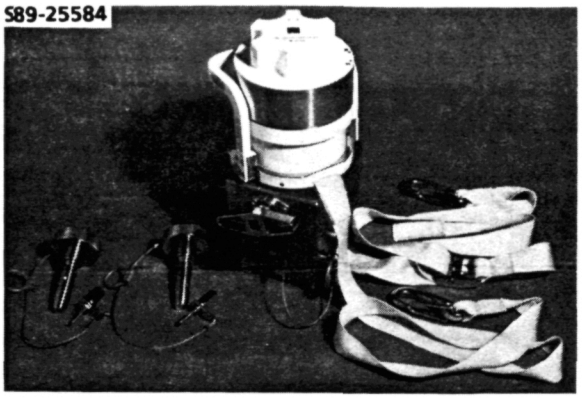
Dimensional Data	
A	0.112 in.
B	5.08 in.
C	0.66 in.
D	2.25 in.



204660184.ART,3

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

TORQUE MULTIPLIER



OVERVIEW

The torque multiplier, reaction arm, and latch pin caddy have been developed to be used with the large cable cutter for jettison of a payload that cannot be stowed or secured for reentry. These items are collectively known as the payload jettison hardware.

The torque multiplier is a planetary gear system with a 3/8-inch square drive input and a socketed output matching the bolts on the payload bay passive latches. The reaction arm aligns the torque multiplier with the passive latch bolt and carries the torque while the bolt is being loosened. The latch pins are used to affix the movable passive latches to their respective mounting points for Shuttle reentry when a payload has been jettisoned. All of these items are stowed in the port provisions stowage assembly (PSA) along with the EVA cable cutter.

OPERATIONAL COMMENTS

The knob on the torque multiplier supplies a 3/8-inch square drive input, a sculptured profile for manual operation, and a ratchet mechanism to limit backdrive within the planetary gear train. The ratchet mechanism works only in the loosening mode, but can be disengaged for free motion in both directions. The torque multiplier interfaces with the reaction arm through a set of splines. A captive T-handled knob with a Delrin swivel pad on its end affixes the two together for use.

Two pin types are stowed in the caddy. One pin, a large shoulder pin with a knurled head, mates with a hole in the passive latch to hold the latch in place; the other smaller pin threads into a hole and holds the first pin in place.

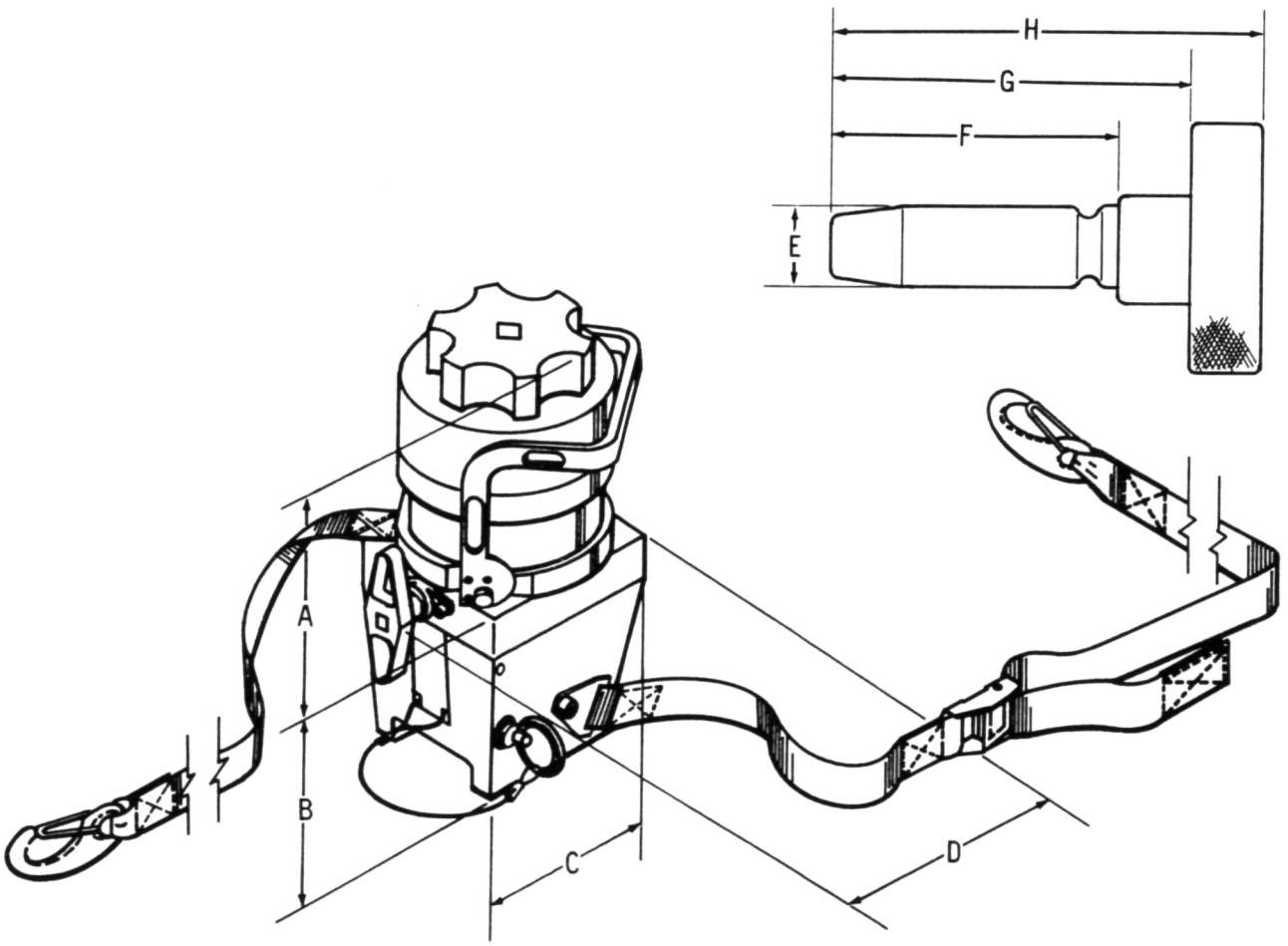
CONTACTS

Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

TORQUE MULTIPLIER

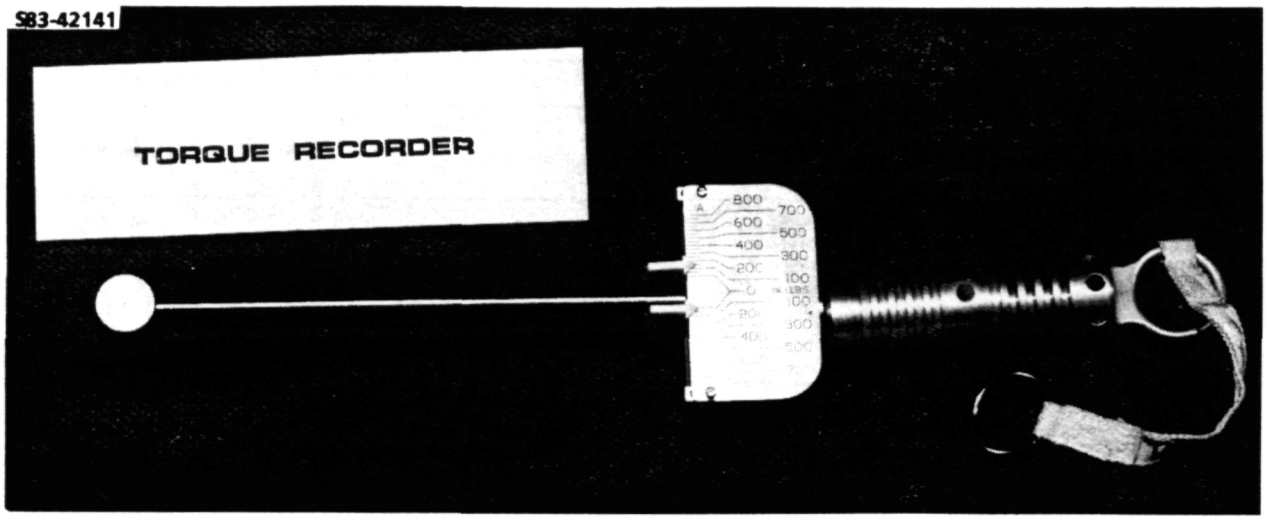
Technical Information	
Part number	10159-10057-01 (payload jettisoning hardware) 10159-20259-01 (torque multiplier) 10159-20260-01 (reaction arm) 10159-20292-01 (latch pin caddy)
Weight	12.5 lb
Material/ construction	Torque multiplier and reaction arm - stainless steel Latch pin caddy pins - Ortho fabric, stainless steel
Temperature range	-200° to +250° F (operational)
Stowage	Port PSA
Availability	Standard

Dimensional Data	
A	4.880 in.
B	4.380 in.
C	3.500 in.
D	5.380 in.
E	0.555 in.
F	2.000 in.
G	2.500 in.
H	3.010 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

TORQUE RECORDER WITH 7/16-INCH HEX SOCKET



OVERVIEW

The torque recorder with 7/16-inch hex socket is a combination of modified common tools. It consists of a modified beam torque wrench with a 7/16-inch socket pinned on. A larger, easily readable torque scale and two sliding torque indicators have been added. A larger handle with tether rings has been added for easier gripping.

OPERATIONAL COMMENTS

The torque recorder with 7/16-inch hex socket was originally designed as a task-simulation device to determine the maximum torque an astronaut could apply. The torque recorder records both clockwise and counterclockwise torques.

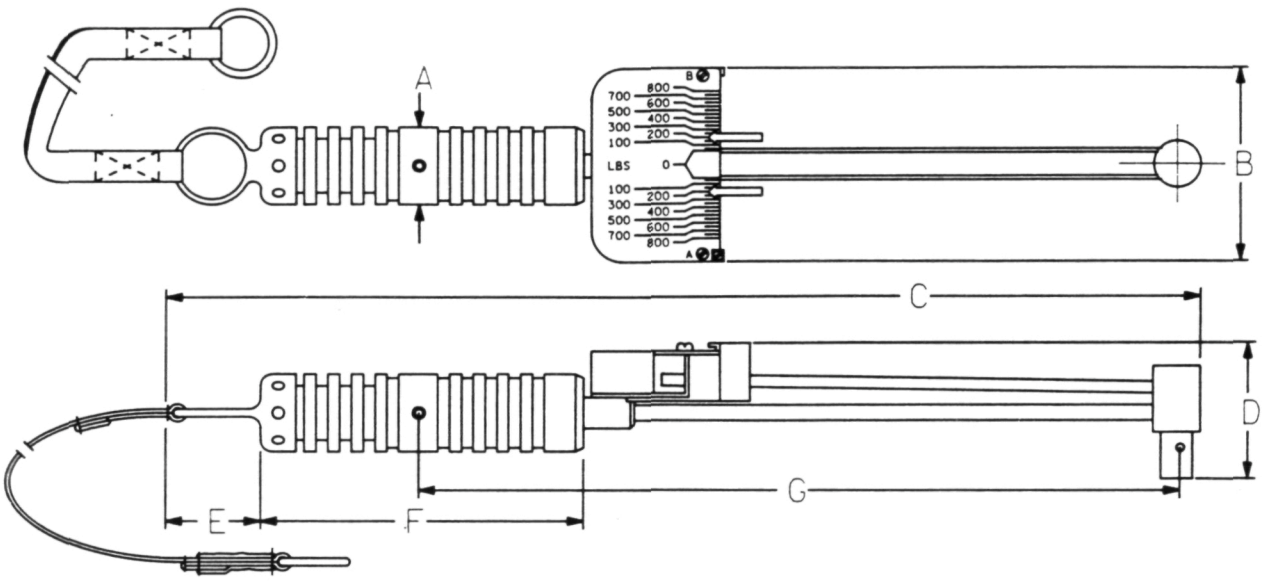
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. E. McElyea, NASA/ES6, (713) 483-8964
Source: M. Withey, ILC Space Systems, (713) 488-9080

TORQUE RECORDER WITH 7/16-INCH HEX SOCKET

Technical Information	
Part number	10159-10001-01
Weight	1.190 lb
Material	Torque wrench - tool steel Handle - aluminum Torque indicator slides - Teflon
Torque scale	Reads up to 800 in-lb in either direction
Socket depth	0.5 in.
Availability	Flight specific

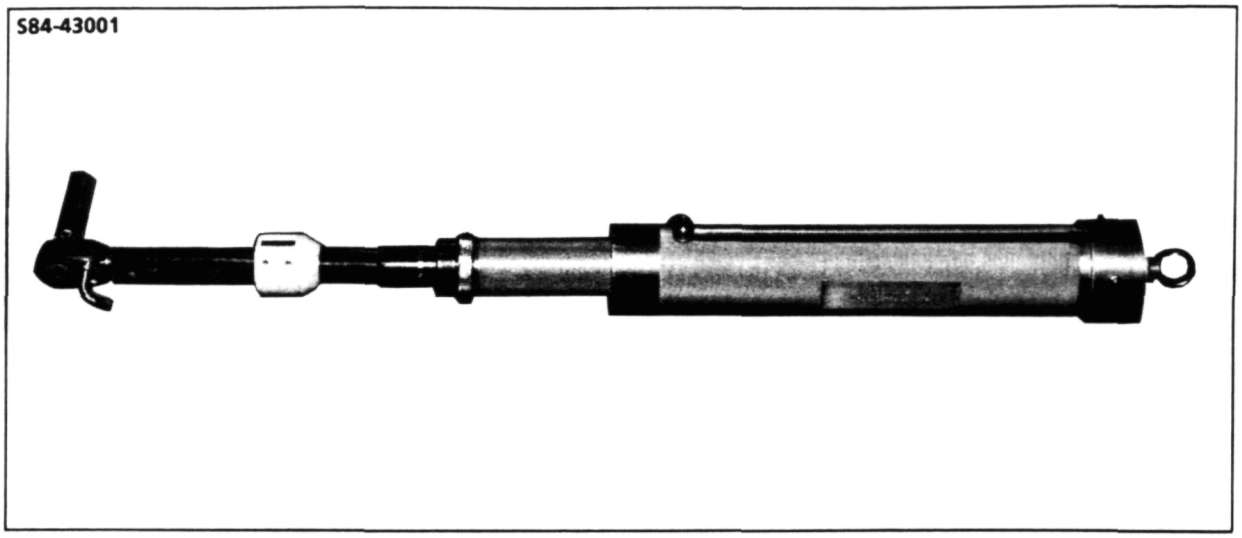
Dimensional Data	
A	1.25 in.
B	3.12 in.
C	16.21 in.
D	2.37 in.
E	1.65 in.
F	4.25 in.
G	11.00 in.



2046660153. ART. 3

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

TORQUE WRENCH



OVERVIEW

The torque wrench is a ratchet wrench designed specifically for use during EVA. The head of the -01 wrench has a 3/8-inch square drive with the option of a 7/16-inch, 12-point hex, deep-well socket or crow foot attachment. A swivel tether is attached to the opposite end of the handle.

OPERATIONAL COMMENTS

The torque wrench extends from a fully retracted length of 17.5 inches to a fully extended length of 26 inches. The torque wrench can apply from 15 to 100 foot-pounds of torque. The lock ring is turned counterclockwise to lock torque setting, clockwise to allow torque adjustment. It was first used on STS 51-A, the Palapa/Westar satellite repair mission, to tighten clamp shoes on the spacecraft adapter. The -02 configuration was used with a crow foot wrench attachment during STS 51-A, but can accept any attachment fitting for a 3/8-inch drive.

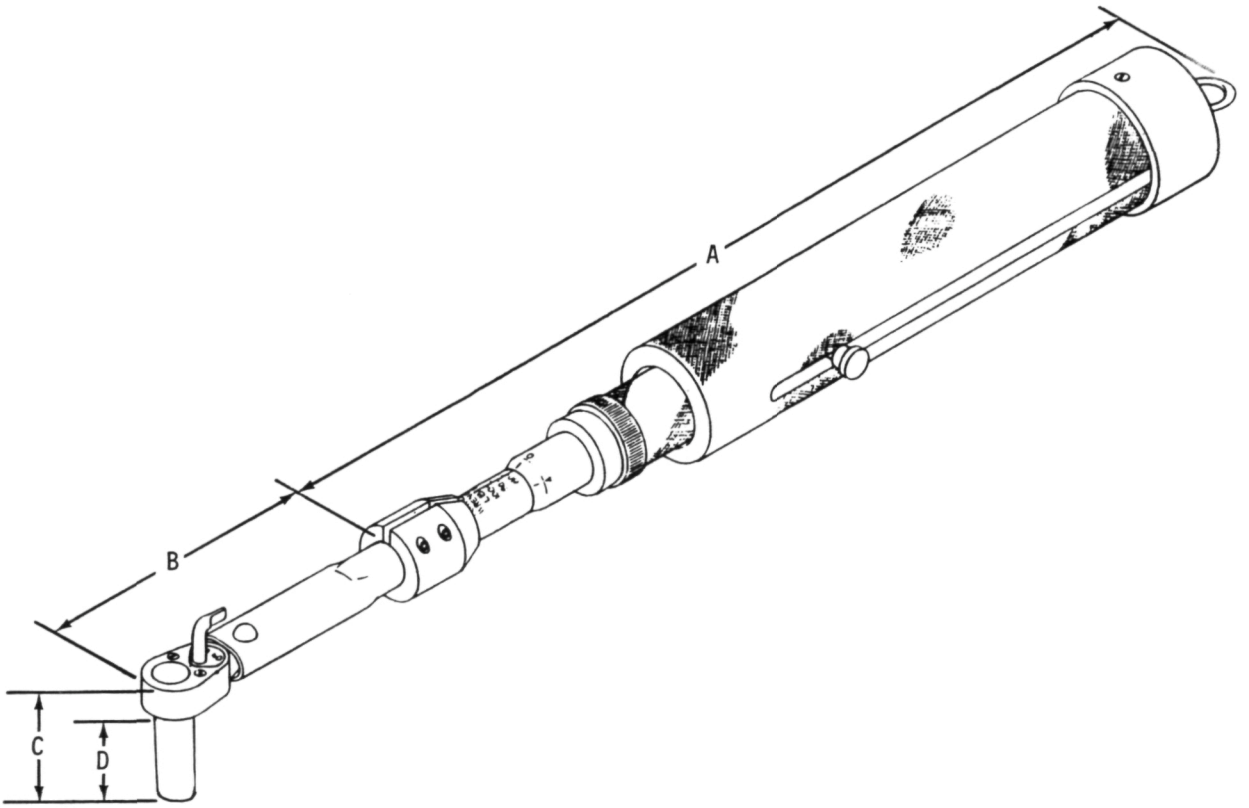
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

TORQUE WRENCH

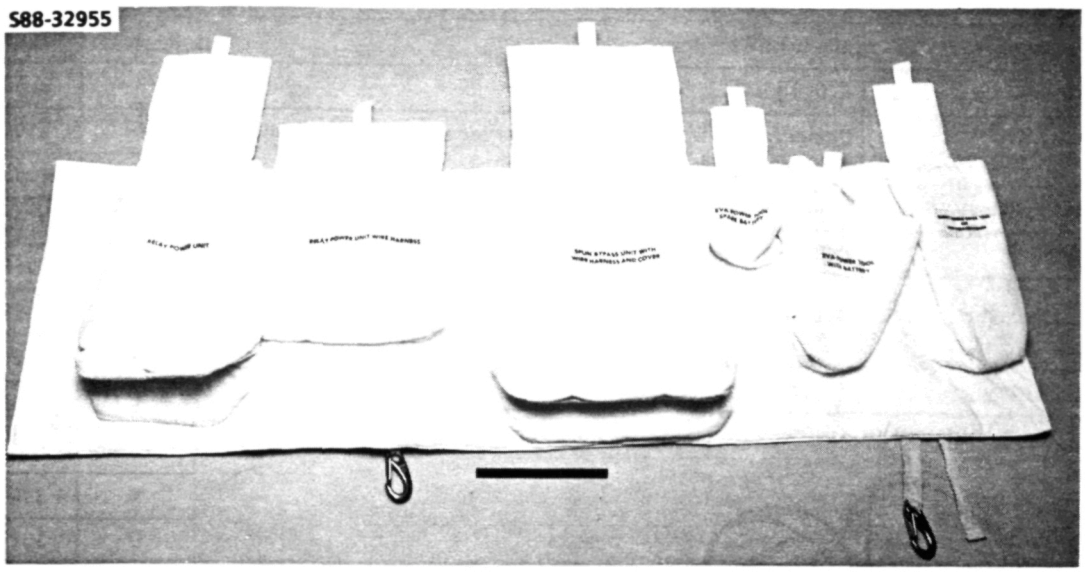
Technical Information	
Part number	10174-20100-01,-02
Weight	3.25 lb
Temperature range	-130° to +150° F
Socket (-01)	7/16-in. 12-pt hex deep well
Torque range	15 to 100 ft-lb
Quantity flown	One for STS 51-A
Stowage	Tool board
Availability	Flight specific

Dimensional Data	
A	26.00 in. expanded 17.50 in. retracted
B	5.00 in.
C	2.63 in.
D	2.00 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

TRANSFER BAG



OVERVIEW

The transfer bag is a thermally protective bag for carrying tools and hardware used for satellite repair. Necessary equipment such as the spun bypass unit with wire harness and cover, the relay power unit, the relay power unit wire harness, the EVA power tool with battery, the EVA power tool spare battery, and the right angle drive tool or pin straightener are all stowed in individual pockets with flaps. Each pocket has a thermal protection layer and a layer of padding to minimize impact damage. The outer cover also provides thermal and impact protection as well as carrying handles and an adjustable strap and hooks for attaching the bag to available work space (e.g., the top of the tool stowage container).

OPERATIONAL COMMENTS

The transfer bag is rolled up and stowed inside the cabin during launch and during activities unrelated to satellite repair. During preparation for the repair part of the mission, the equipment needed is packed into the appropriate pockets. The bags are then transferred into the airlock for use during the EVA. Two of these bags were successfully used on STS 51-I. Two bags were provided, one for redundancy.

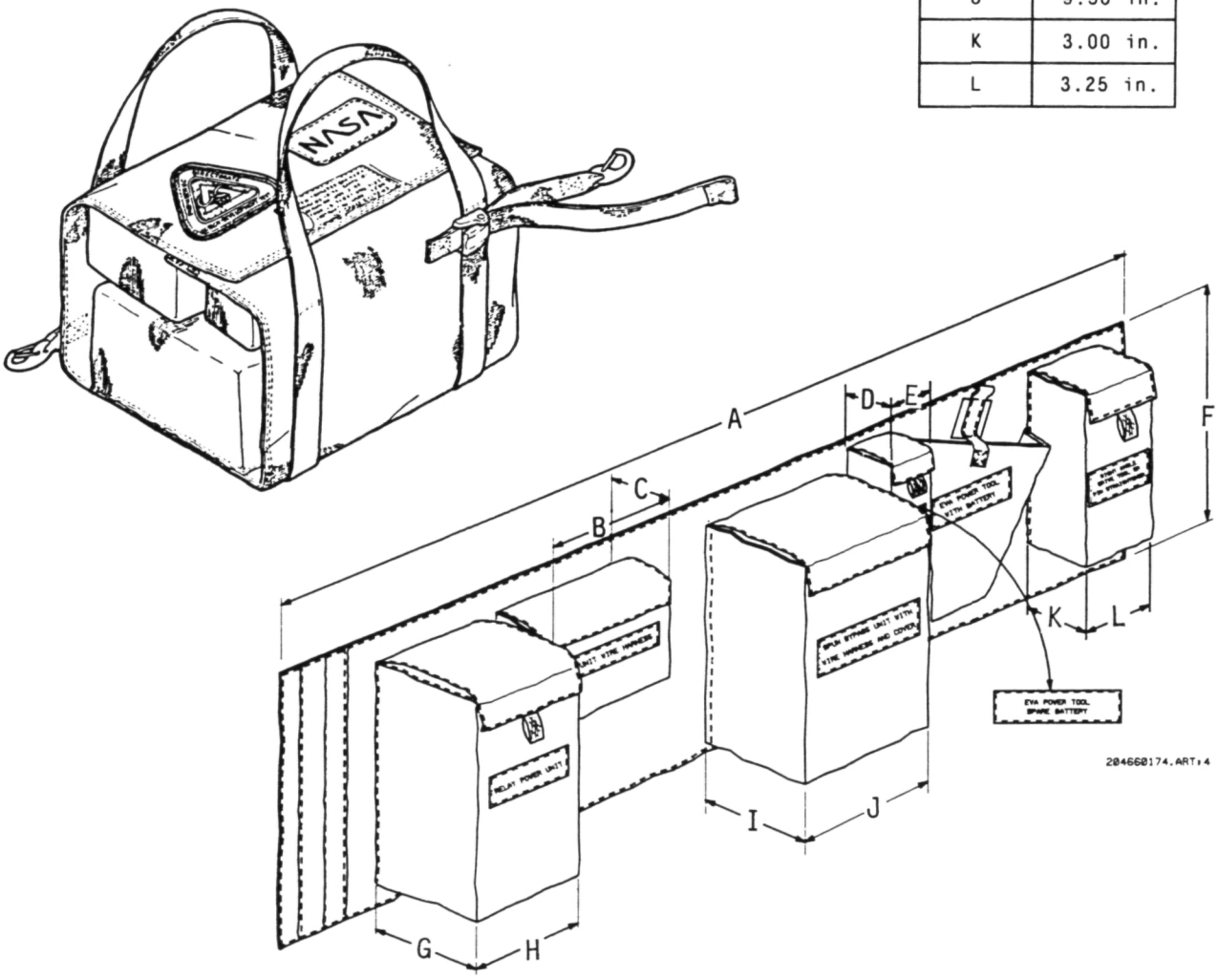
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483-2589
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

TRANSFER BAG

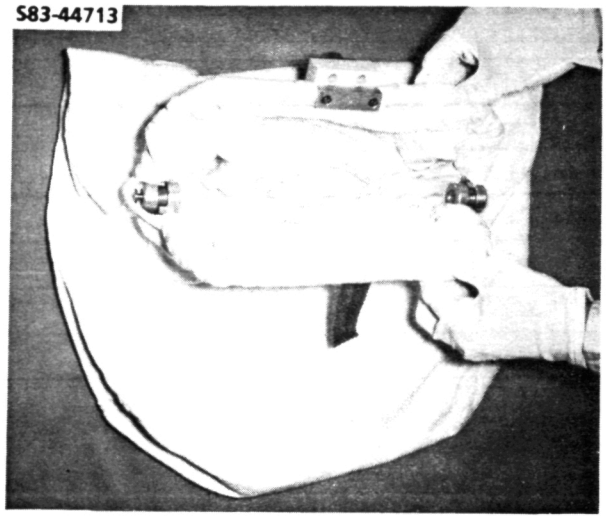
Technical Information	
Part number	10176-20006-01
Weight	6.6 lb
Material	Ortho, aluminized mylar, polyester scrim, Nomex needle punch batting, Teflon
Quantity flown	Two for STS 51-I
Stowage	Cabin locker
Availability	Flight specific

Dimensional Data	
A	55.00 in.
B	9.50 in.
C	2.00 in.
D	2.50 in.
E	3.00 in.
F	16.50 in.
G	7.25 in.
H	6.00 in.
I	7.50 in.
J	9.50 in.
K	3.00 in.
L	3.25 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

TRASH BAG, LARGE



OVERVIEW

The large EVA trash bags are dual-layered containers for the stowage of tools and equipment discarded during an EVA. The bags are identical in dimensions, but differ in detail depending upon the particular needs of the mission.

OPERATIONAL COMMENTS

The 10173-20041 bag and the 10176-20157 bag (primary) both have overlapping baffles so that the bag restrains small items even when the closure is pulled open. The 10176-20157 bag has a Velcro strap on the back which can be wrapped around the work station stanchion for stability. The 10176-20160 bag (secondary) is identical to the 10176-20157 bag without the Velcro strap and the baffle. Absence of the baffle allows insertion of large items.

The 10176-20157 bag was successfully flown on STS 51-I and restrained tool boards and other items removed from the Syncom F-3 satellite. The 10176-20160 bag was also flown on STS 51-I and contained a folded sheet of aluminum from the Syncom perigee kick motor nozzle. Both STS 51-I bags remained on top of the Leasat equipment stowage assembly for landing. The 10173-20041 bag was used for STS 41-C and STS 51-A.

All three bags are attached by means of a mini work station interface adapter pin. The attachment hardware must withstand launch loads when bags are empty and landing loads when items are stowed in the bags.

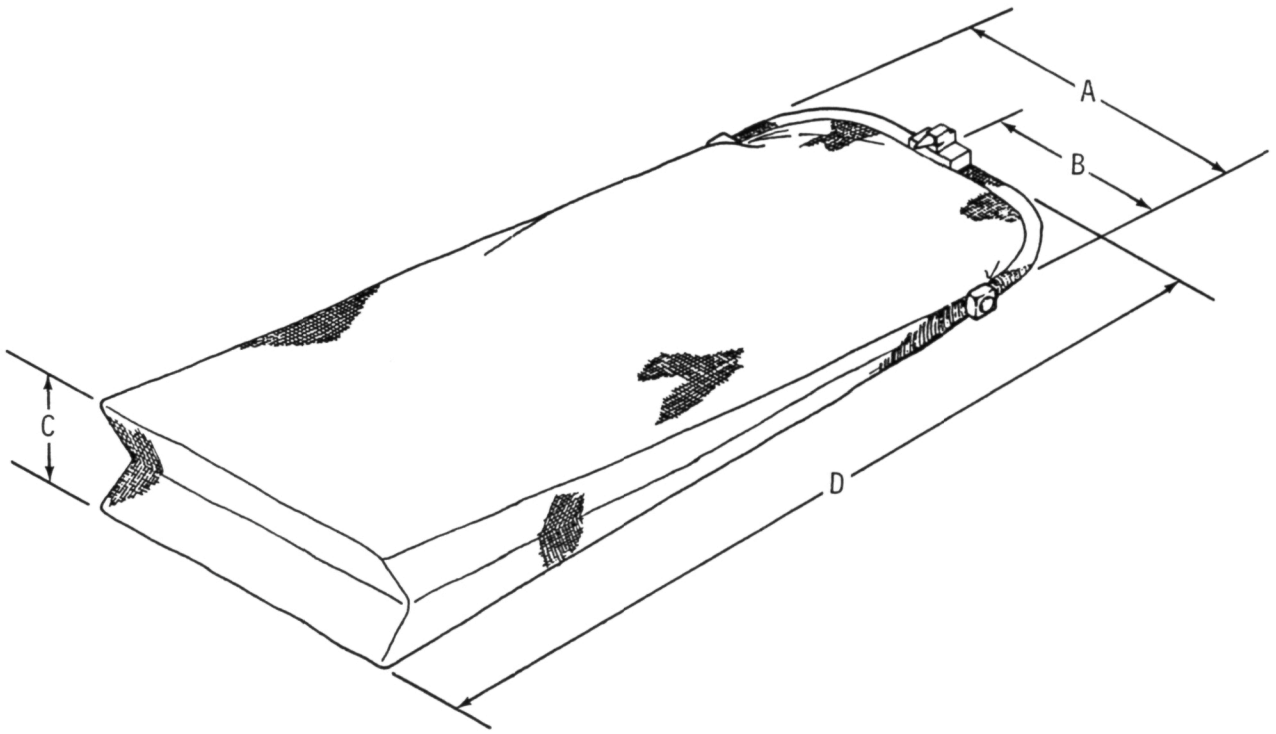
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

TRASH BAG, LARGE

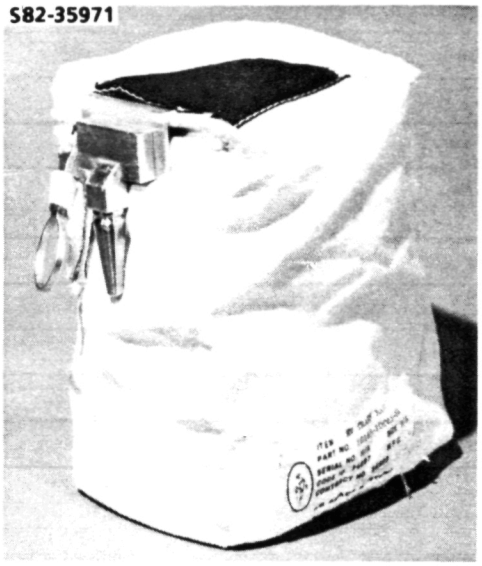
Technical Information	
Part number	10173-20041-01, 10076-20157-01, 10076-20160-01
Weight	2.2 lb
Material	Ortho and Teflon fabrics
Maximum opening	10 in.
Stowage	Payload bay
Availability	Flight specific

Dimensional Data	
A	12.0 in.
B	6.0 in.
C	4.0 in.
D	30.0 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

TRASH BAG, SMALL



OVERVIEW

The small trash bag, also known as the EVA trash bag, is used on the mini work station (MWS) to contain discarded nuts, bolts, and small trash items during EVA.

OPERATIONAL COMMENTS

The bag is fabricated of Nomex fabric and has a snap frame closure device. The baffle opening at the top of the bag is fabricated from a blue Nomex fabric to facilitate visual recognition of the opening by the EVA crewmember. The bag has a tether ring and is secured to the MWS by an interface adapter pin which locks into place.

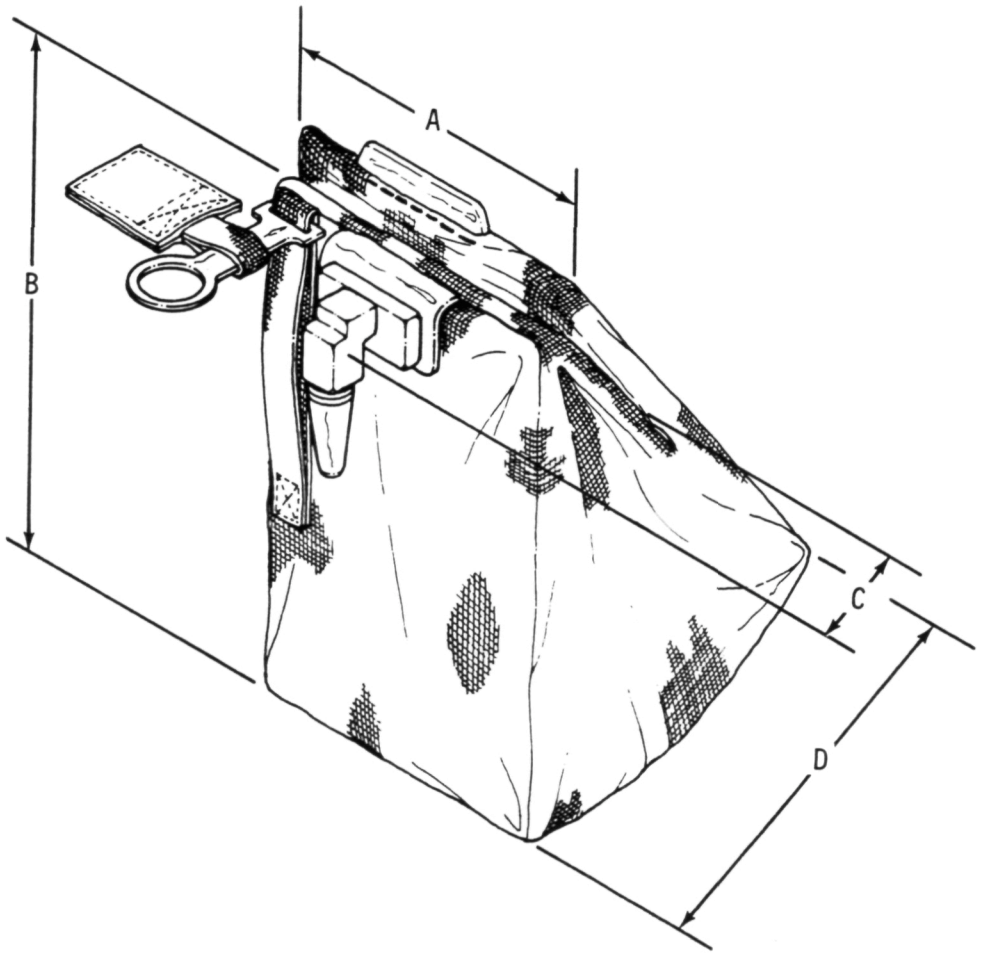
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: M. Withey, ILC Space Systems, (713) 488-9080

TRASH BAG, SMALL

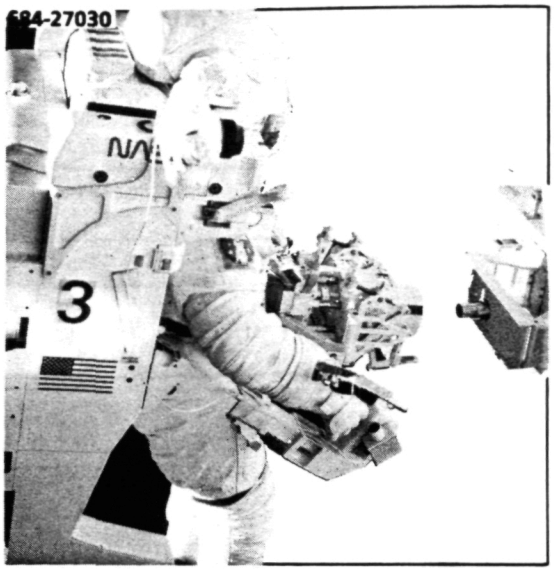
Technical Information	
Part number	10165-10065-03
Weight	1.0 lb
Baffle opening	3.5 in.
Depth in open position	4.75 in.
Temperature range	-200° to 250° F (operational)
Stowage	Starboard provisions stowage assembly
Availability	Standard

Dimensional Data	
A	4.50 in.
B	7.30 in.
C	2.70 in.
D	6.00 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

TRUNNION PIN ATTACHMENT DEVICE



OVERVIEW

The trunnion pin attachment device (TPAD), mounted on the manned maneuvering unit (MMU), is used to capture and stabilize a multimission modular spacecraft (MMS)-type satellite. It can also be used to attach a grapple fixture to a satellite for connection to the remote manipulator system (RMS).

OPERATIONAL COMMENTS

The TPAD consists of three parts: the control assembly, the primary assembly, and the secondary assembly. All are attached to the MMU by two brackets held by pip pins. The control assembly provides jaw action and locking control and allows the primary assembly to be detached from the control assembly. The primary assembly attaches the crewmember and MMU to the TPAD satellite for stabilization. A secondary TPAD assembly may be rotated up to take the place of the primary TPAD assembly in case of a primary TPAD failure.

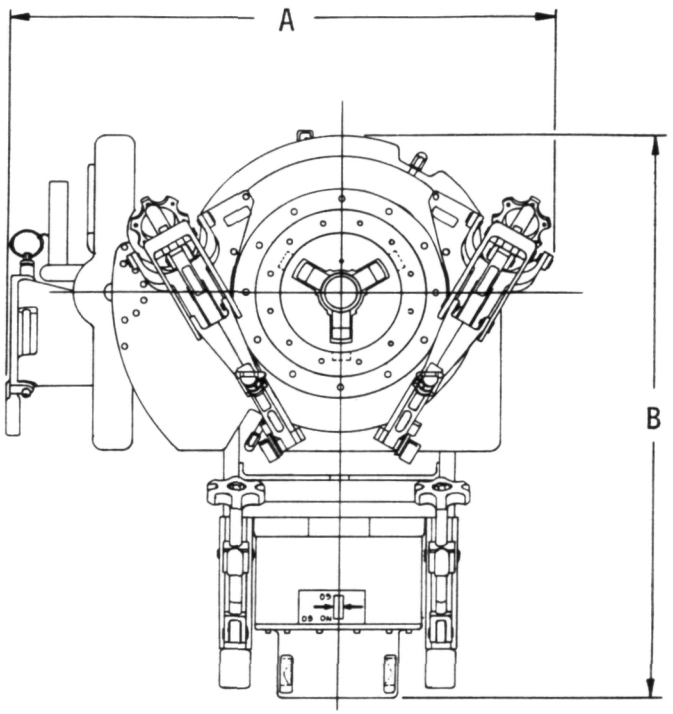
CONTACTS

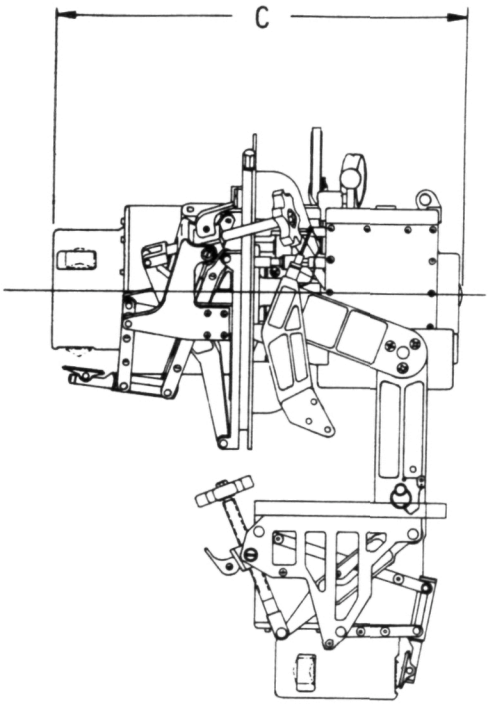
Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: C. S. Allton, NASA/EC2, (713) 483-9152
Source: M. Withey, ILC Space Systems, (713) 488-9080

TRUNNION PIN ATTACHMENT DEVICE

Technical Information	
Part number	10169-10069-01
Weight	106.5 lb
Quantity flown	One for STS 41-B and 41-C
Stowage	Flight support system locker and special equipment stowage assembly
Availability	Flight specific

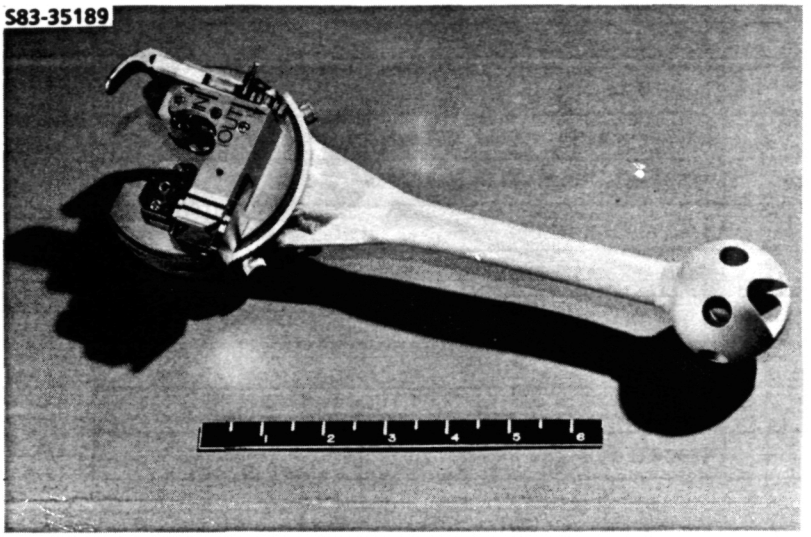
Dimensional Data	
A	27.22 in.
B	28.48 in.
C	20.78 in.





ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

TUBE CUTTER



OVERVIEW

The tube cutter consists of spring-loaded retention rollers, a cutter blade mounted on a slide, a blade ratchet handle, and a cutter ratchet handle. The cutter wheel is made of tool steel with hardness of 60 RC. The drive links are made of heat-treated Inconel 718 with a hardness of 36 to 38 RC. The tool is preset to cut tubes with 1/2- to 3/4-inch diameters but can be readjusted to cut 3/4- to 1-inch diameter tubes by flipping the slide 180° and moving the cutter blade to the second screw hole.

OPERATIONAL COMMENTS

The tube cutter is a disconnect tool necessary for the contingency door closing operation. For operation, the tool is pushed onto the tube and held in place by the retention rollers while the cutter blade is ratcheted down onto the tube. The large ratcheted handle is then used to rotate the cutter on the tube, and the blade is tightened down as required. Only a nominal force is required by the operator when cutting a drive tube.

This tool is part of the normally manifested STS equipment and is stowed in the starboard provisions stowage assembly (PSA).

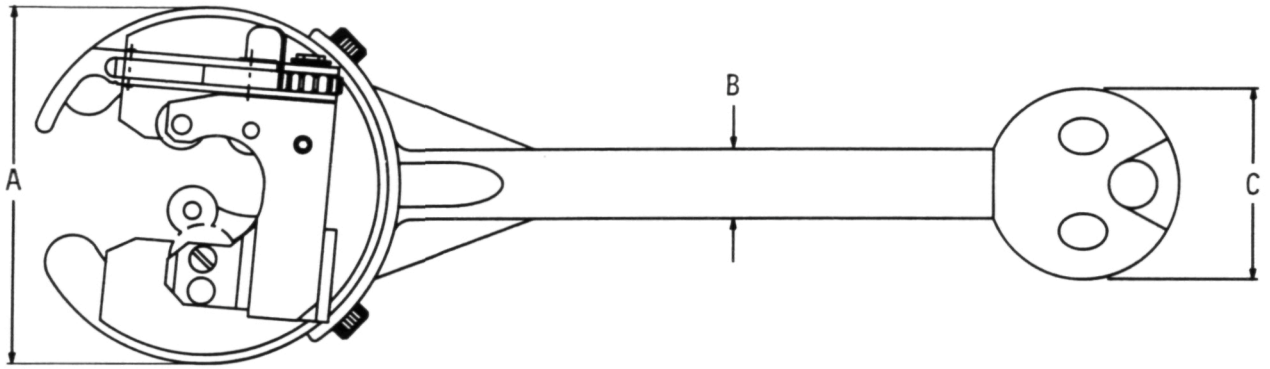
CONTACTS

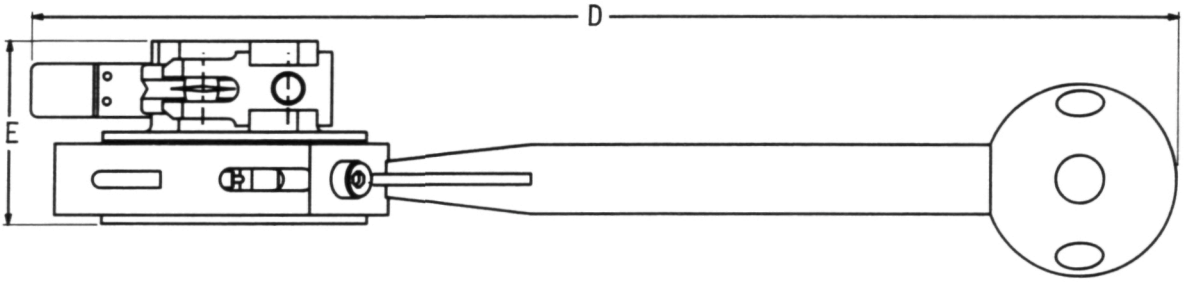
Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: T. Ross, NASA/ES6, (713) 483-8941
Source: T. Ross, NASA/ES6, (713) 483-8941

TUBE CUTTER

Technical Information	
Part number	SED33101368-301
Weight	1.7 lb
Material	Cutter wheel - AISI type 01 tool steel, 60 RC
Temperature range	-200° to 250° F
Cutting range	1/2-in. to 1-in. diameter
Drive links	Made of heat-treated Inconel 718, 36 to 38 RC
Quantity flown	One in starboard PSA
Availability	Standard

Dimensional Data	
A	3.60 in.
B	0.75 in.
C	2.00 in.
D	12.00 in.
E	1.90 in.

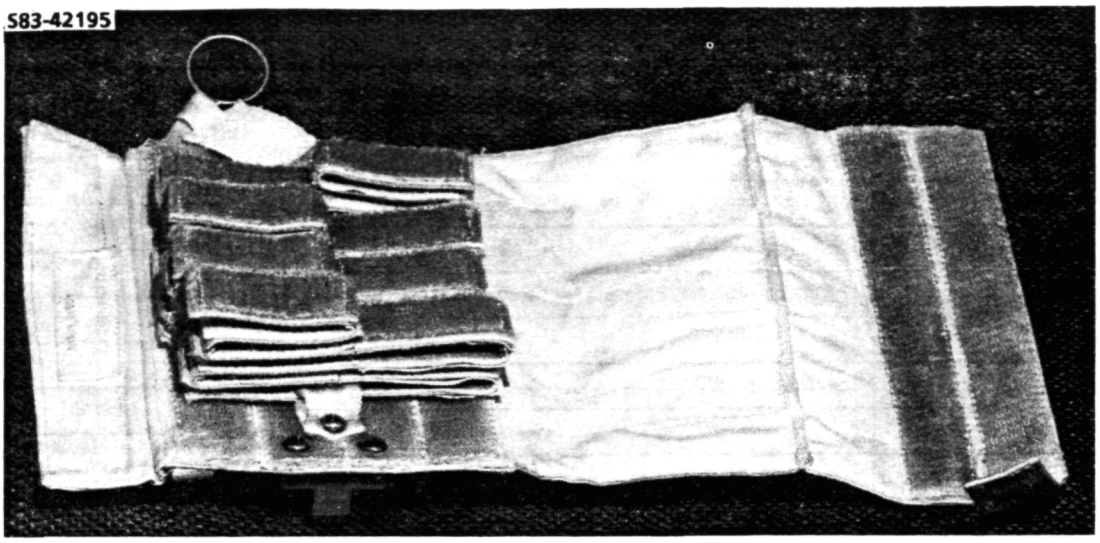




204660158.ART, 2

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

VELCRO CADDY



OVERVIEW

The Velcro caddy, also called the door drive linkage (DDL) Velcro set, is a foldup fabric container which holds four Velcro tethers for use in restraining disconnected mechanisms or miscellaneous loose equipment during EVA.

OPERATIONAL COMMENTS

The four Velcro tethers contained in the Velcro caddy are 22-7/8 inches long and are fabricated of 1-inch by 2-inch alternating segments of hook and loop Velcro sewn on both sides of Armalon material. A tab on one end and a D-ring on the other assist in handling by EVA crewmembers. The tethers are stowed folded back and forth upon themselves in the caddy. This assembly is part of the normally manifested EVA hardware and is stowed in the starboard provisions stowage assembly (PSA).

CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: M. Withey, ILC Space Systems, (713) 488-9080

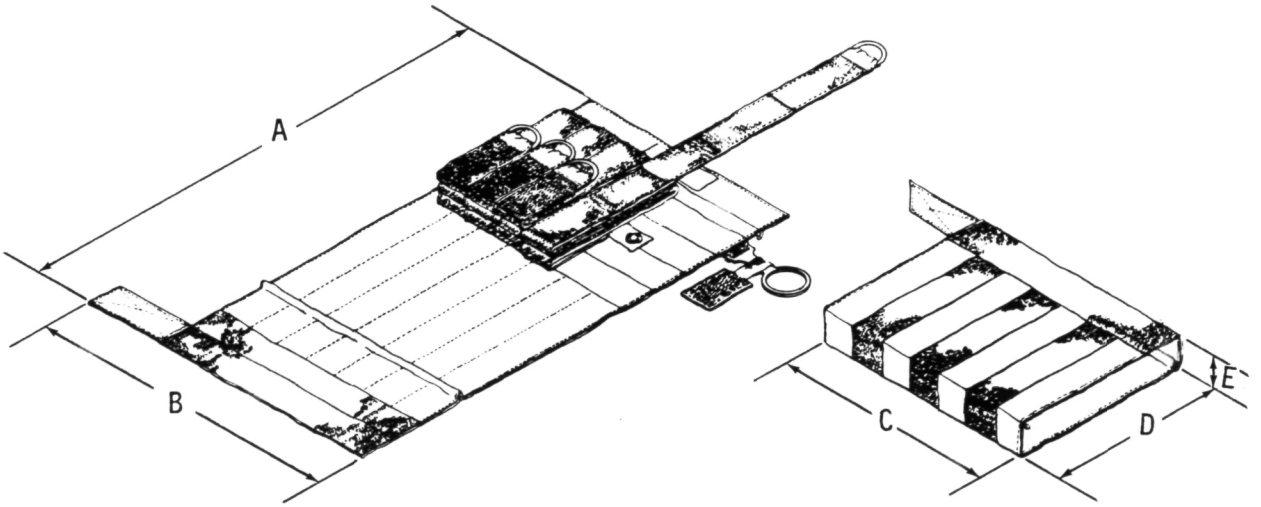
Section
PAGE 4 INTENTIONALLY BLANK

PRECEDING PAGE BLANK NOT FILMED

VELCRO CADDY

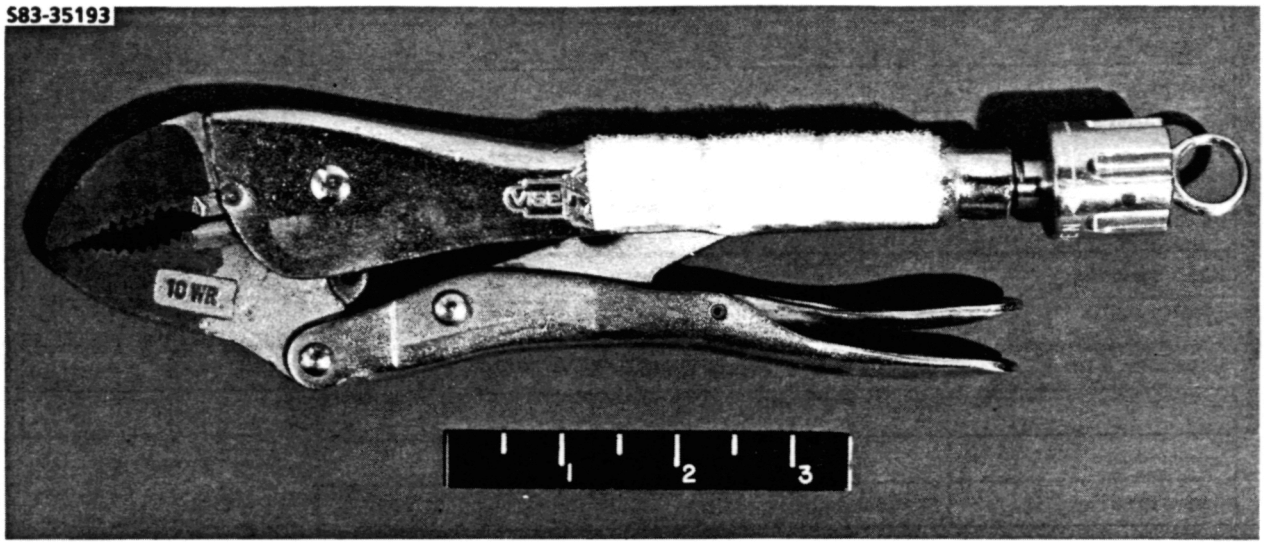
Technical Information	
Part number	10159-20006-02
Weight	1.8 lb
Material	Caddy - Nomex Strips - polyester, Velcro, Armalon
Strip width	1.0 in.
Strip length	20.0 in.
Temperature range	-200° to 250° F (operational)
Quantity flown	One
Stowage	Starboard PSA
Availability	Standard

Dimensional Data	
A	14.5 in.
B	9.5 in.
C	7.0 in.
D	5.5 in.
E	1.0 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

VISE-GRIP PLIERS



OVERVIEW

The vise-grip pliers are a common tool modified for EVA use. The pliers have a clamping jaw design equipped with an adjuster. Turning this adjuster controls the size and force required for bolt gripping. A spring in the mechanism holds the jaws clamped. The handle is wrapped with Velcro and has a ring for tether attachment. The tool has a maximum opening of 1-5/8 inches.

OPERATIONAL COMMENTS

The normal use for the vise-grip pliers is to grasp the nut during nut and bolt removals. They can also be used for jam removal. Both the size and force adjustments are controlled by the knob on the end of the handle. This tool is part of the normally manifested STS equipment. It is stowed in a Velcro-lined tool caddy along with the bolt puller in the starboard provisions stowage assembly (PSA). The standard vise-grip wire cutters have not been modified for this tool.

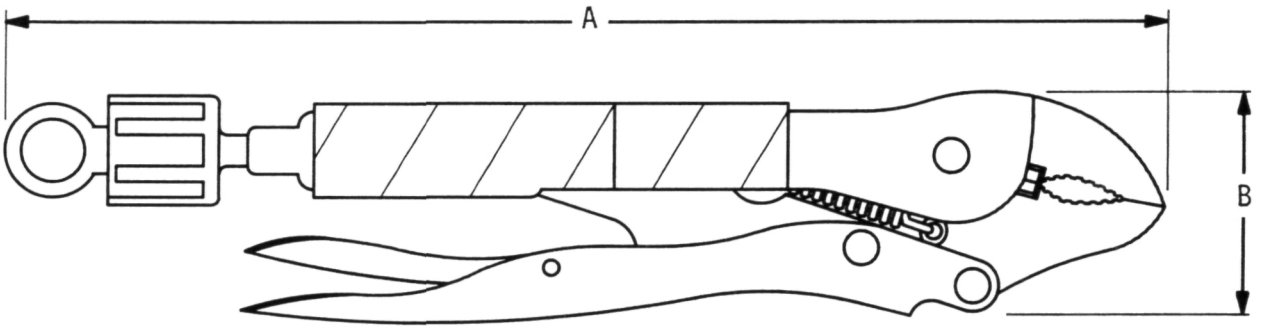
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: J. Madden, Rockwell/Houston, (713) 282-5300

VISE-GRIP PLIERS

Technical Information	
Part number	V628-650876-001 or SDD33103436-301
Weight	1.2 lb
Material/ construction	Forged steel, standard Snap-On tool modified for EVA Handle - Velcro-wrapped, control knob Jaws - serrated, notched Lubricant - Molykote 321R
Max. opening	1-5/8 in.
Temperature range	-200° to 250° F (operational)
Quantity flown	One in the starboard PSA
Availability	Standard

Dimensional Data	
A	10.06 in.
B	2.50 in.

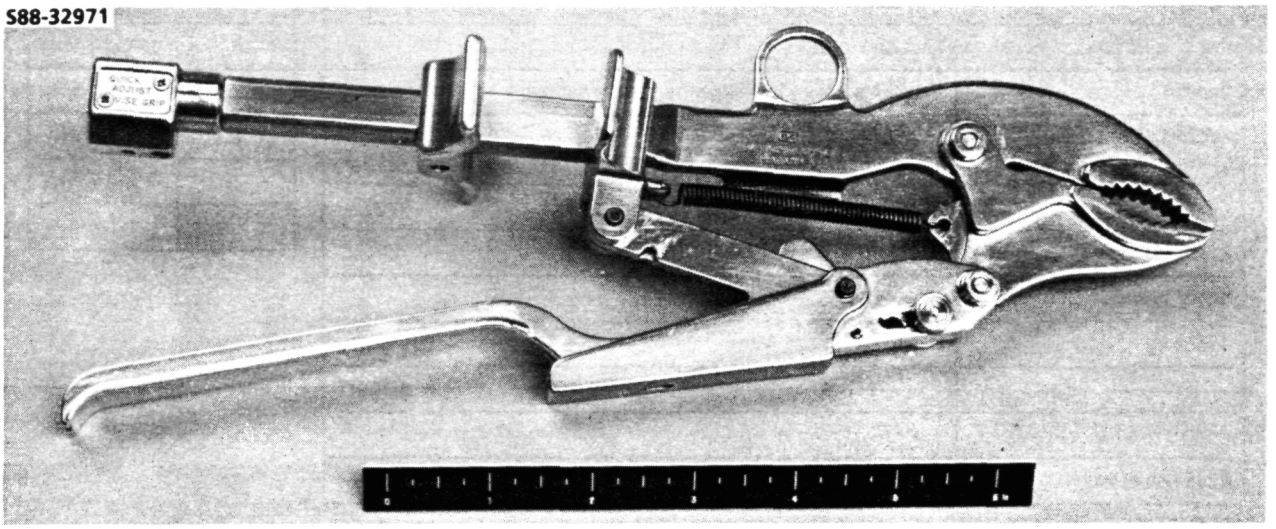


204660161.ART, 3

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

VISE-GRIP PLIERS, ONE-HANDED

S88-32971



OVERVIEW

The quick-adjust vise grips are similar to standard off-the-shelf vise grips except that the tool is designed for one-handed operation. The tool is manifested as a contingency tool for EVA. A tether ring is provided at the top of the tool near the jaws.

OPERATIONAL COMMENTS

Adjustment of the vise grips is accomplished by sliding the adjustment collar to the desired position and allowing the jaws to fit over the object to be gripped. Positively gripping the object is performed by squeezing the long handle on the bottom of the tool. To release, squeeze the small handle at the base of the long handle.

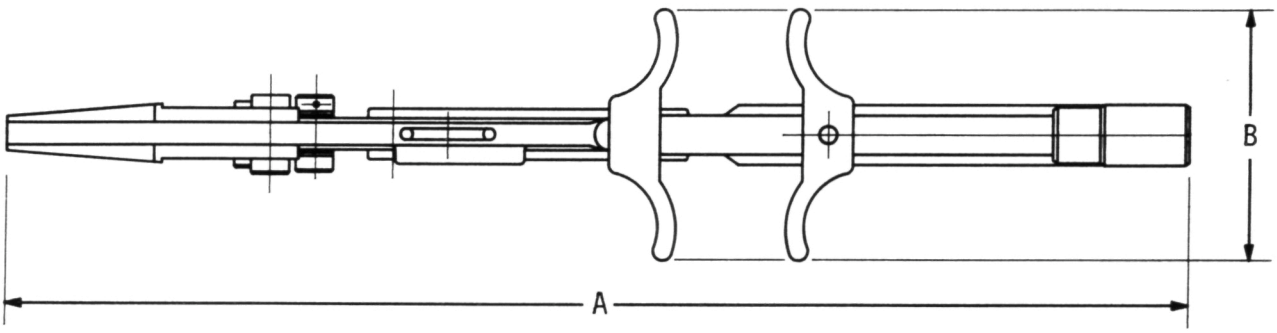
CONTACTS

Operational: S. Boyd, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

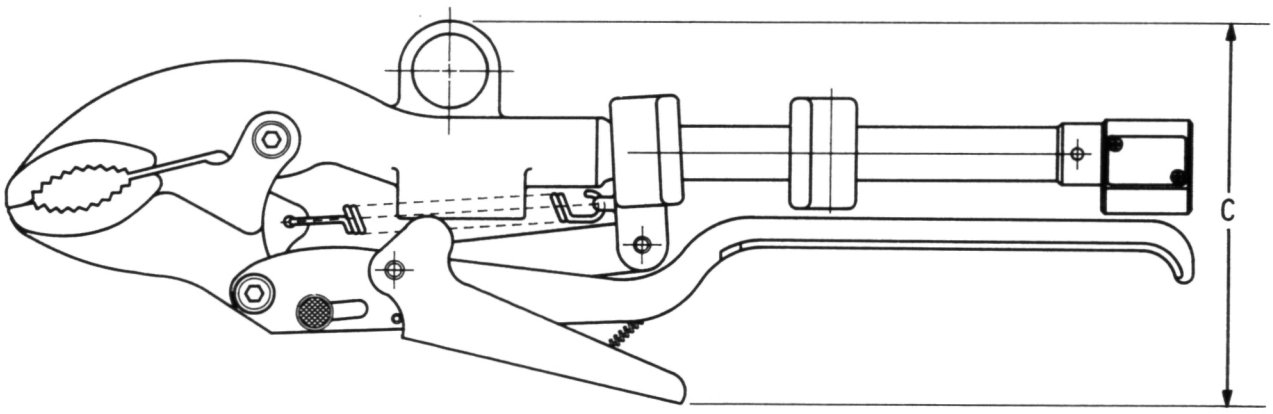
VISE-GRIP PLIERS, ONE HANDED

Technical Information	
Part number	10159-10038-1
Weight	1.62 lb
Material/ construction	Stainless steel
Temperature range	-130° to +150° F (operational)
Maximum opening	1.80 in.
Grip range	Up to 1.25 in. thickness
Opening diameter	0.38 to 1.62 in.
Availability	Developmental

Dimensional Data	
A	11.80 in.
B	2.50 in.
C	3.80 in.



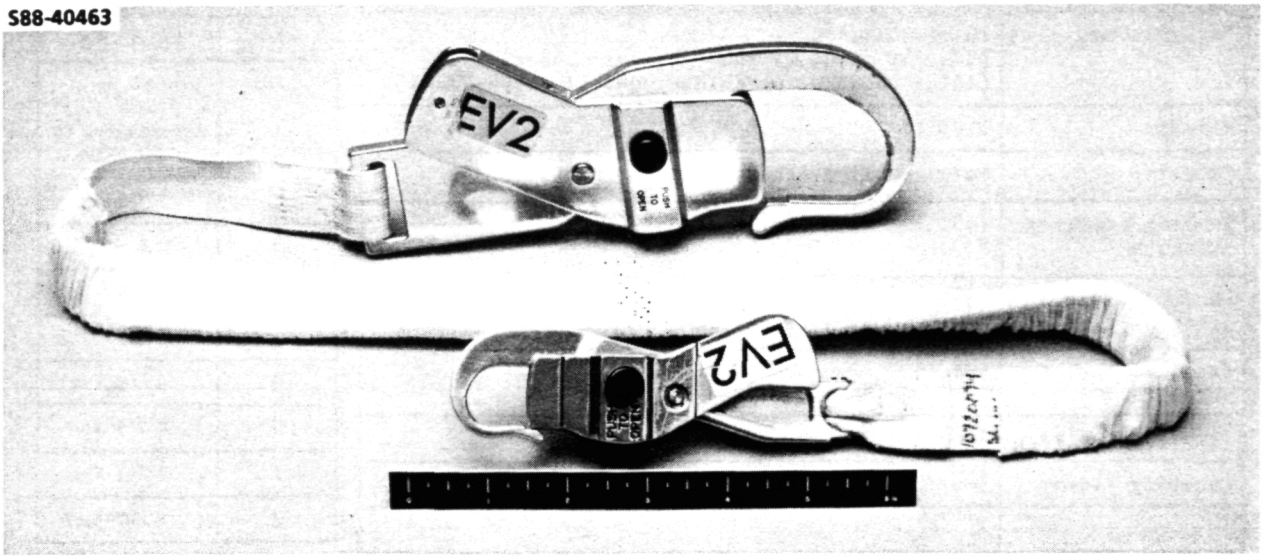
204660182A.ART, 1



204660182B.ART, 1

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

WAIST TETHER



OVERVIEW

The waist tether consists of a strip of Nomex webbing material with an aluminum EVA hook on each end (one hook is larger than the other). The tether is nominally 37 inches long including the hooks. The tether incorporates a load-limiting feature which allows no more than 75 pounds to be imparted to the extravehicular mobility unit (EMU) and safety tether/slidewire system until full extension of the tether occurs. If this load is exceeded, the web stitching will break and absorb kinetic energy to decelerate the crewmember. After all web stitching is broken, the tether will withstand a limit load of 585 pounds. A Teflon fabric sleeve retains any broken threads to minimize sources of EVA contamination.

OPERATIONAL COMMENTS

Waist tethers are used to attach the crewmember to the Orbiter or to tether a tool to the crewmember. The large hook is attached to handrails, and the small hook is attached to an EMU waist tether ring. Opening of an EVA hook requires that push-to-open buttons on each side be depressed simultaneously while the hook is squeezed. The hook will spring closed as soon as it is released. The small hook opens 0.59 inch, and the large hook opens 0.91 inch. Two waist tethers are normally attached to each EMU.

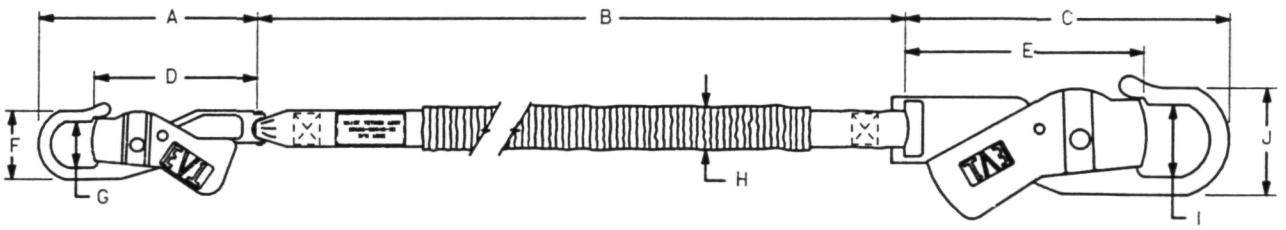
CONTACTS

Operational: C. H. Armstrong, NASA/DF42, (713) 483-2588
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: M. Withey, ILC Space Systems, (713) 488-9080

WAIST TETHER

Technical Information	
Part number	10151-20040-05, (9792-01 or 10181-10046-01 small hook) (10151-20083-01 or 10181-10047-01 large hook)
Weight	0.93 lb
Material	Nomex webbing strap, aluminum hooks
Webbing breaking strength	1400 lb
Load limit before extension	75 lb
Extended tether strength	585 lb
Temperature range	-200° to 250° F (operational)
Quantity flown	Two for each EMU
Availability	Standard

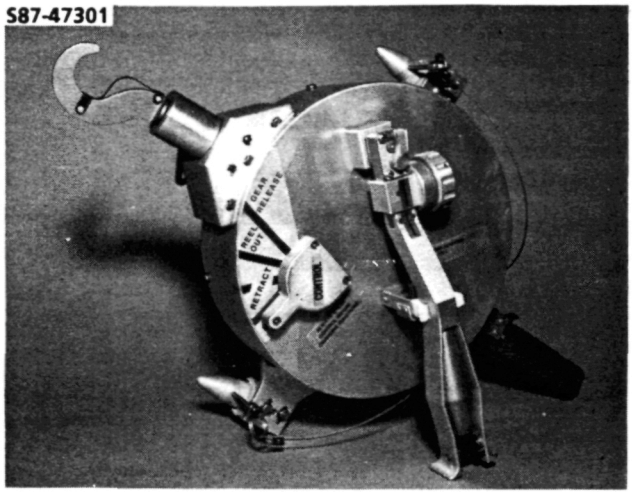
Dimensional Data	
A	5.00 in.
B	Normal - 24.50 in. Break-away 84.50 in.
C	7.25 in.
D	4.13 in.
E	5.25 in.
F	1.35 in.
G	0.75 in.
H	1.00 in.
I	1.50 in.
J	2.30 in.



204660162.ART, 5

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

WINCH, EVA



OVERVIEW

The EVA winch consists of Kevlar rope, a housing, a reel, a stowable ratchet handle, and a mounting adapter. A rope guide with rollers to prevent fraying is mounted on the housing. A ratchet lever is used to select reverse, neutral, and engage positions, while the control handle selects ratchet in, retract, reel out, and gear release positions. The winch has 24 feet of 3/8-inch-diameter Kevlar rope with a hook attached to the end. The hook fits a 1.25-inch-diameter shaft on the bulkhead latch. The winch has a power ratio of 18.6 to 1.

OPERATIONAL COMMENTS

The winch is used to close the payload bay doors manually in the event the door drive system fails. One winch is mounted on each of the forward and aft cargo bay bulkheads. After all apparent obstructions to door movement have been removed and any necessary disconnect and/or cutting operations completed, the crewmember routes the rope over the number 4 hook roller and attaches the rope hook to the number 4 latch bellcrank at the tip of the door. The winch may also be used to elevate or lower the IUS tilt table. A load of 600 pounds can be applied on the rope by placing the control to ratchet in and engage and by cranking the ratchet handle.

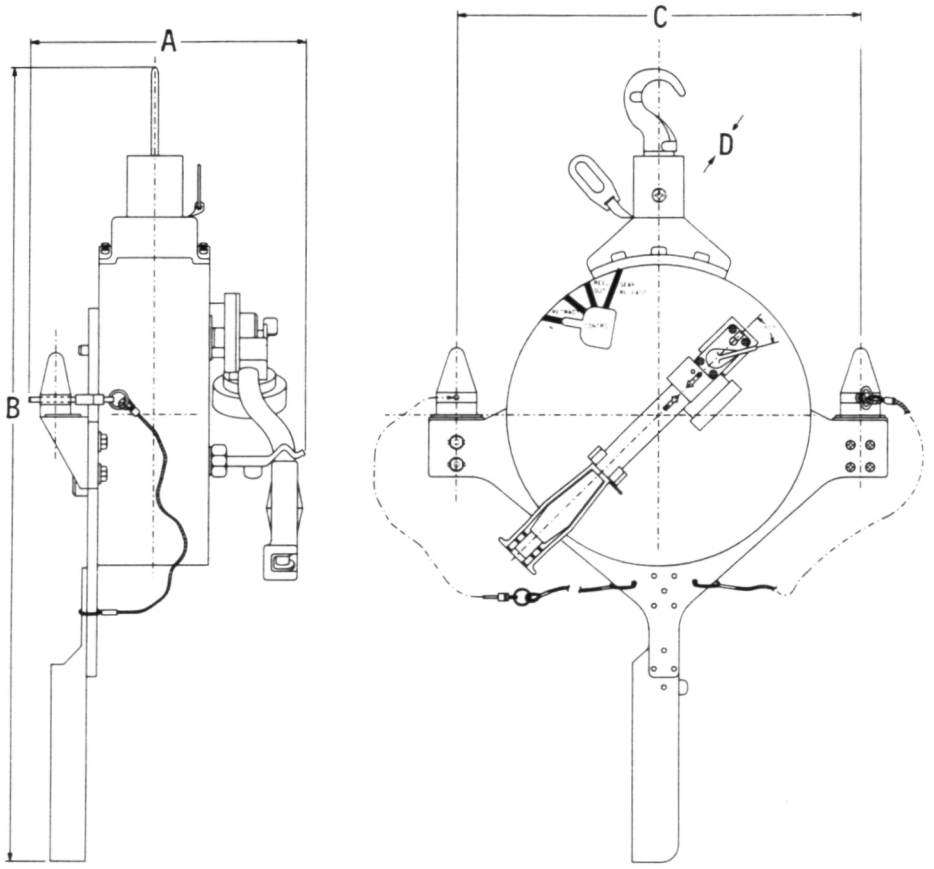
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: T. Ross, NASA/ES6, (713) 483-8941
Source: T. Ross, NASA/ES6, (713) 483-8941

WINCH, EVA

Technical Information	
Part number	SED33101570-309/311
Weight	24 lb forward, 21 lb aft
Material	Aluminum alloy
Rope length	24 ft
Rope diameter	0.375 in. Kevlar
Hook opening	1.25 in.
Rope tension limit	584 lb by the adapter
Power ratio	18.6 to 1.0
Operating temperature	-250° to +275° F
Quantity flown	Two mounted on cargo bay bulkhead
Availability	Standard

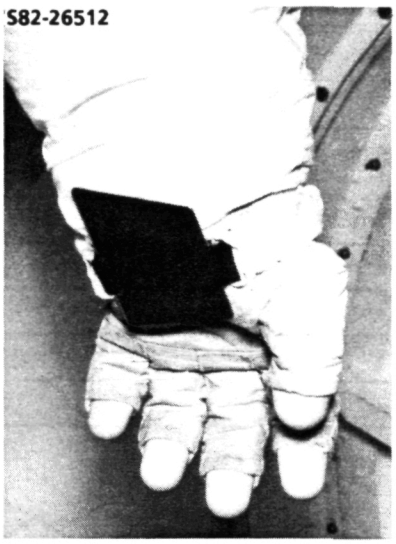
Dimensional Data	
A	8.50 in.
B	26.00 in.
C	13.50 in.
D	1.25 in.



204660163.ORT, 3

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

WRIST MIRROR



OVERVIEW

The wrist mirror, also called the extravehicular mobility unit (EMU) mirror band, is attached to the wrist of the EMU glove to allow the EVA crewmember to view the gauges and dials on the front of the EMU. The mirror can be worn on either wrist and is stowed on the left glove before flight.

OPERATIONAL COMMENTS

The wristband of the EMU mirror band is a stainless steel Twistoflex watchband encased in Teflon fabric. The mirror is attached to the band by straps that loop through slits in the mirror edge. The mirror itself is constructed of highly polished chrome-plated steel.

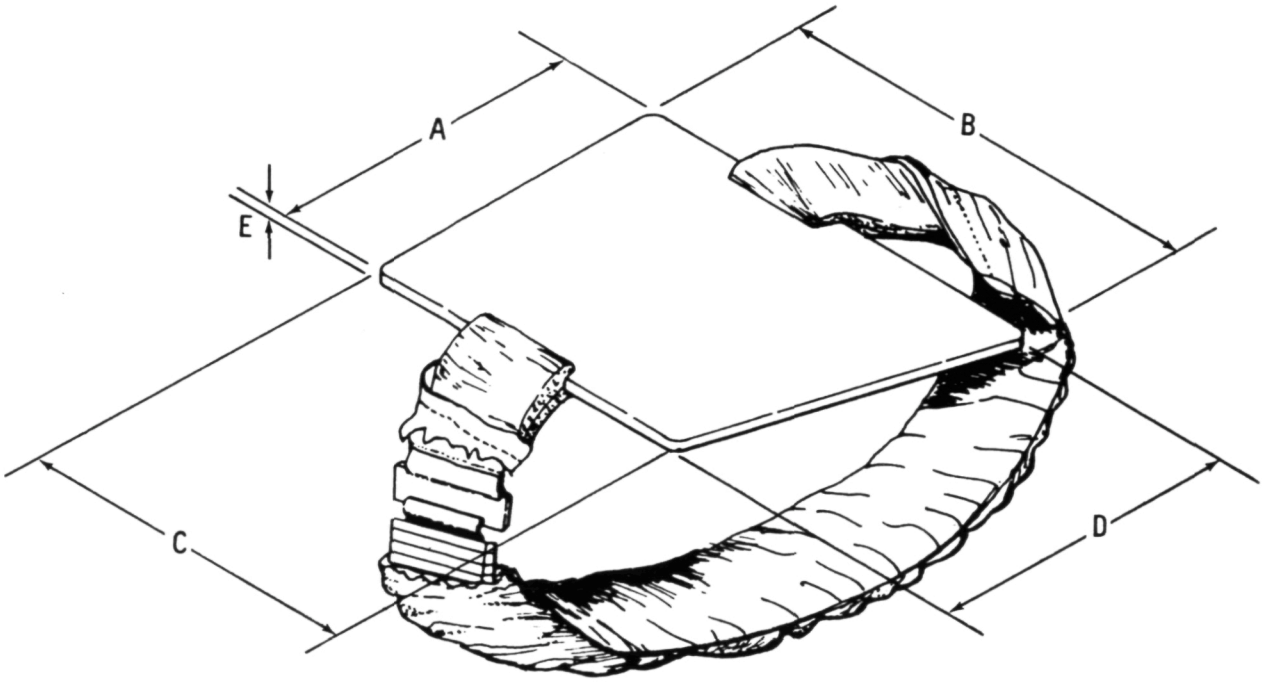
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483-2589
Technical: R. J. Marak, NASA/EC5, (713) 483-9144
Source: M. Withey, ILC Space Systems, (713) 488-9080

WRIST MIRROR

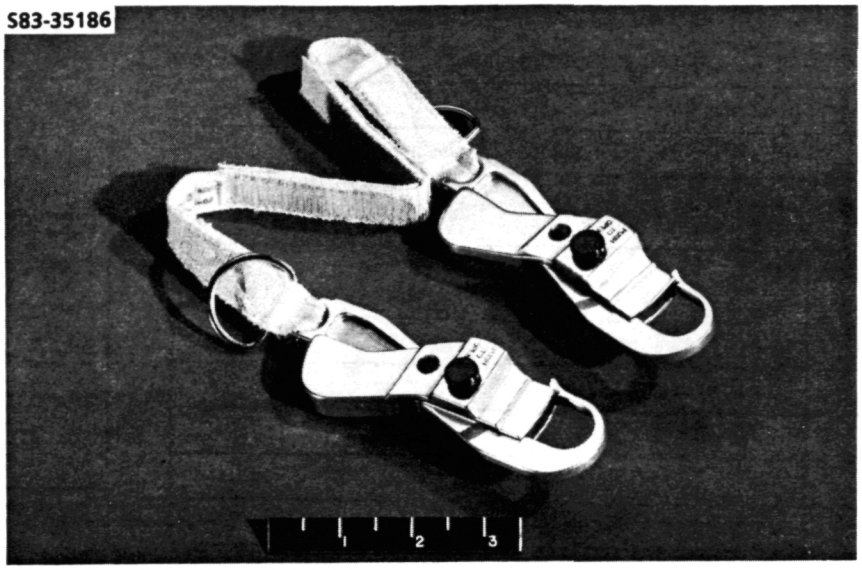
Technical Information	
Part number	10108-10012-02
Weight	0.30 lb
Material	Mirror - chrome-plated stainless steel Strap - stainless steel covered with Teflon
Quantity flown	One for each prime EMU
Stowage	EMU left glove
Availability	Standard

Dimensional Data	
A	2.190 in.
B	3.000 in.
C	2.310 in.
D	2.250 in.
E	0.031 in.



ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

WRIST TETHER



OVERVIEW

This type of wrist tether has a fixed-length strap and a small EVA hook on each end. The wrist tether attaches to loops on the extravehicular mobility unit (EMU) gloves. The fixed-length tether is 22.8 inches long, including hooks, and is constructed of a Nomex webbing material with aluminum hooks.

OPERATIONAL COMMENTS

The wrist tether is used to secure tools and hardware to the suited crewmember and tether points. Opening of an EVA hook requires that push-to-open buttons on each side be depressed simultaneously while the hook is squeezed. The hook has a maximum opening of 0.59 inch and will spring closed as soon as it is released. One fixed-length wrist tether is normally attached to the right glove of the EMU.

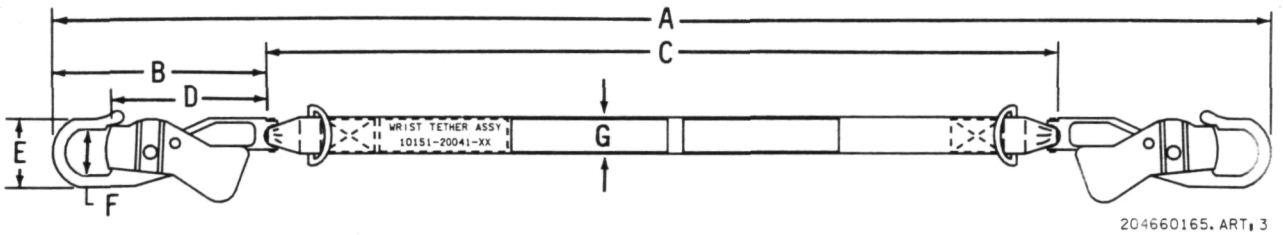
CONTACTS

Operational: C. H. Armstrong, NASA/DF42, (713) 483-2588
Technical: W. B. Wood, NASA EC6, (713) 483-9247
Source: M. Withey, ICL Space Systems, (713) 488-9080

WRIST TETHER

Technical Information	
Part number	10151-20041-02 (9792-01 hooks)
Weight	0.52 lb
Material	Nomex webbing strap, aluminum hooks
Webbing breaking strength	1400 lb
Operational load limit	585 lb
Quantity flown	One for each prime EMU
Stowage	Right glove
Availability	Standard

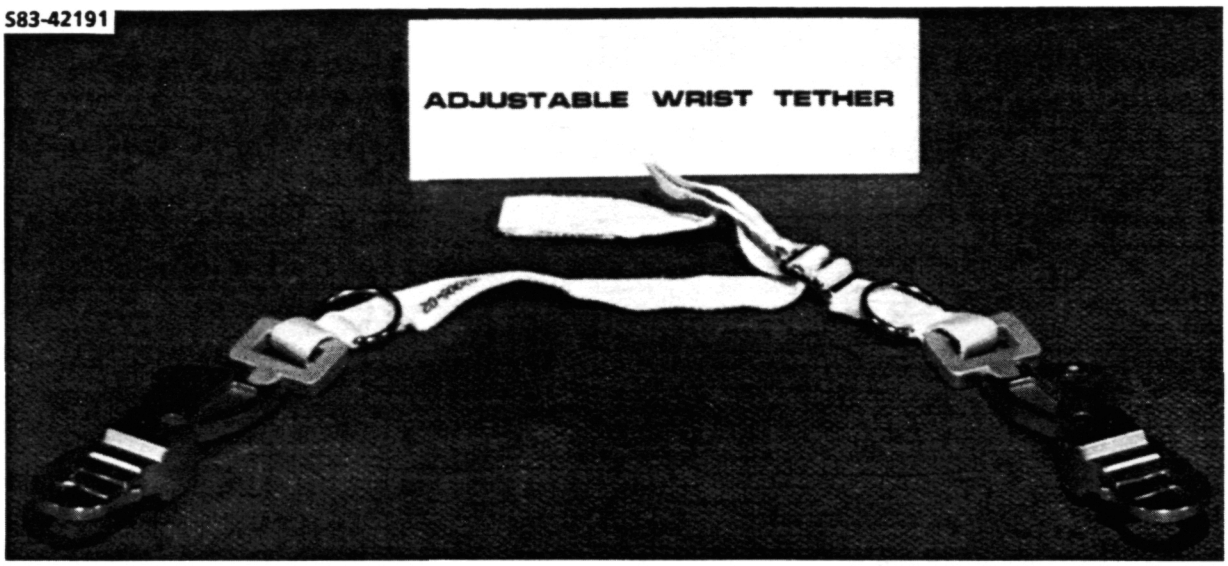
Dimensional Data	
A	22.80 in.
B	5.00 in.
C	12.80 in.
D	4.13 in.
E	1.35 in.
F	0.75 in.
G	0.70 in.



204660165.ART, 3

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

WRIST TETHER, ADJUSTABLE



OVERVIEW

The adjustable wrist tether attaches to the extravehicular mobility unit (EMU) glove to secure tools to the suited crewmember or other tether points. The tether length can vary from 28 to 40 inches, including a small EVA hook on each end. The tether is made of Nomex webbing with aluminum EVA hooks, an adjustment slide, and D-rings.

OPERATIONAL COMMENTS

Opening of an EVA hook requires that push-to-open buttons on each side be depressed simultaneously while the hook is squeezed. The hook has a maximum opening of 0.59 inch and springs closed as soon as it is released.

The length of the tether is adjusted with an adjustable slide. Velcro fabric on the free end of the tether strap provides a grip for the crewmember and secures the free end to the strap to prevent slippage. Two adjustable wrist tethers are normally manifested and stowed in the starboard provisions stowage assembly (PSA).

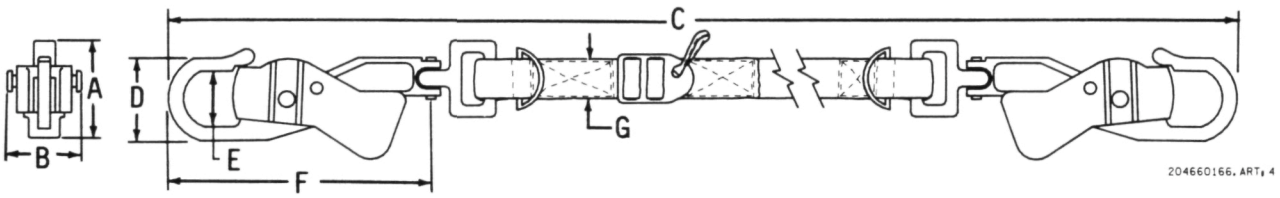
CONTACTS

Operational: C. H. Armstrong, NASA/DF42, (713) 483-2588
Technical: W. B. Wood, NASA/EC6, (713) 483-9247
Source: M. Withey, ICL Space Systems, (713) 488-9080

WRIST TETHER, ADJUSTABLE

Technical Information	
Part number	10159-20005-02/03 (9792-01 hooks)
Weight	0.615 lb
Material	Hooks - aluminum Strap - Nomex
Webbing breaking strength	1400 lb
Operational load limit (buckle)	70 lb
Temperature range	-200° to 250° F (operational)
Quantity flown	Two
Stowage	Starboard PSA
Availability	Standard

Dimensional Data	
A	2.00 in.
B	1.31 in.
C	28.00 ± 1 in. 40.00 ± 1 in.
D	1.35 in.
E	0.75 in.
F	5.00 in.
G	0.75 in.



APPENDIX A
COMMENT/REQUEST RETURN FORM

Name
Organization
Mail code
Address
Phone number

If you have any recommendations which could improve the content or format of this document, please take a few moments to note your suggestions on this form. Submit comments or requests for additional copies to

Robert C. Trevino
NASA Johnson Space Center - DF42
Houston, Texas 77058

1. Technical content

2. Format and organization

3. Additions or deletions

4. Other comments

APPENDIX B
SUPPLEMENTAL TOOL INFORMATION

This appendix is a modified version of the one found in the original publication. This edition notes the past flight manifest of selected Shuttle missions and the EVA compatibility of each item. The grading scale for EVA compatibility is based on human factors considerations which are recommended for EVA design practices. These ratings are purely subjective and were agreed upon by a consensus of experienced EVA crewmembers and engineers. Ratings were assigned by assessing each item's function and frequency of operation. The ratings are limited to: highly recommended, recommended, and not recommended.

Rating	Description
Highly recommended	Follows good human factors design for EVA operation with a pressurized suit or gloved hand. Easily operated with convenient adjustments to accommodate different crewmembers. True one-handed operation possible. Close to optimum design.
Recommended	Provides acceptable accommodations for EVA operation. No significant deficiencies limiting use.
Not recommended	Design minimally accommodates a pressurized suit or gloved hand. Operation may require excessive or overly repetitive force inputs. Purpose of item better accomplished with alternate design.

Item	Title of tool	Past flight manifest								EVA compatibility
		STS-5	STS-6	STS 41-B	STS 41-C	STS 41-G	STS 51-A	STS 51-I	STS 61-B	HR - Highly recommended R - Recommended NR - Not recommended
1	1/2-inch allen wrench for 3/8-inch drive									R
2	1/2-inch drive ratchet									NR
3	1/2-inch open end wrench									NR
4	1/2-inch ratcheting box end wrench			✓	✓	✓	✓	✓	✓	HR
5	1/4-inch allen wrench extension for 3/8-inch drive	✓	✓	✓	✓	✓	✓	✓	✓	R
6	1/4-inch allen wrench extension for 3/8-inch drive (IPS)									R
7	1/4-inch crow's foot wrench				✓					NR
8	1/4-inch drill extension for 3/8-inch drive				✓					R
9	15/16-inch wrench with cheater bar									NR
10	3/8-inch drive McTether ratchet									HR
11	3/8-inch drive ratchet	✓	✓	✓	✓	✓	✓	✓	✓	NR
12	3/8-inch drive ratchet (SAL)									NR
13	3/8-inch drive ratchet with 7/16-inch hex socket	✓	✓	✓	✓	✓	✓	✓	✓	NR
14	3/8-inch drive ratchet with 7/16-inch hex socket extension	✓	✓	✓	✓	✓	✓	✓	✓	NR
15	3/8-inch drive ratchet, EVA			✓	✓		✓	✓		HR
16	3/8-inch drive ratchet, EVA with 7/16-inch hex socket		✓							HR
17	35-mm camera	✓	✓	✓	✓	✓	✓	✓	✓	R
18	35-mm camera cover	✓	✓	✓	✓	✓	✓	✓	✓	R
19	35-mm camera mount	✓	✓	✓	✓	✓	✓	✓	✓	R
20	5/16-inch hex socket for 3/8-inch drive						✓			R
21	5/16-inch hex socket for 3/8-inch drive (HST)									R
22	7/16-inch and 1/2-inch box end wrench									R
23	7/16-inch hex socket extension for 3/8-inch drive			✓	✓		✓	✓		HR

Item	Title of tool	Past flight manifest								EVA compatibility
		STS-5	STS-6	STS 41-B	STS 41-C	STS 41-G	STS 51-A	STS 51-I	STS 61-B	HR - Highly recommended R - Recommended NR - Not recommended
24	7/16-inch hex socket extension for 3/8-inch drive (HST)									HR
25	7/16-inch hex socket for 3/8-inch drive (HST)									HR
26	7/16-inch open end wrench									NR
27	7/16-inch ratcheting open end wrench			✓	✓					R
28	Adjustable wrench	✓	✓	✓	✓	✓	✓	✓	✓	NR
29	Airlock	✓	✓	✓	✓	✓	✓	✓	✓	N/A
30	Airlock stowage bag	✓	✓	✓	✓	✓	✓	✓	✓	R
31	Antenna bridge structure						✓			NR
32	Antenna cutter						✓			R
33	Apogee kick motor capture device						✓			R
34	Apogee kick motor nozzle cover						✓			R
35	Bag, EVA	✓	✓	✓	✓	✓	✓	✓	✓	R
36	Bar stowage assembly							✓		R
37	Bar, capture							✓		R
38	Bar, grapple							✓		R
39	Bar, handling							✓		R
40	Bar, spin-up							✓		R
41	Bolt puller	✓	✓	✓	✓	✓	✓	✓	✓	R
42	Bolt, EVA hex-head						✓	✓		HR
43	Cable cutter						✓	✓	✓	R

Item	Title of tool	Past flight manifest								EVA compatibility
		STS-5	STS-6	STS 41-B	STS 41-C	STS 41-G	STS 51-A	STS 51-I	STS 61-B	HR - Highly recommended R - Recommended NR - Not recommended
44	Cable cutter, compound									R
45	Cable cutter, large									R
46	Cargo bay stowage assembly	✓	✓	✓	✓					R
47	Carryout bracket									NR
48	Centerline latch bypass tool	✓	✓	✓	✓	✓	✓	✓	✓	NR
49	Centerline latch tool bag	✓	✓	✓	✓	✓	✓	✓	✓	R
50	Circular connector tool									R
51	Coax connector tool									R
52	Coax connector tool, round									R
53	Contingency strut wrench									NR
54	Coupling, Helium II resupply									R
55	Cuff checklist	✓	✓	✓	✓	✓	✓	✓	✓	R
56	D-connector demate tool									R
57	D-connector mate tool									R
58	Diagonal cutters	✓	✓	✓	✓	✓	✓	✓	✓	NR
59	Door stay, adjustable, SSM									R
60	Door stay, OTA									R
61	Door support bracket				✓					R
62	Drive unit preload tool									NR
63	Drop-proof tether			✓	✓		✓	✓		HR
64	Electrical circular connector tool							✓		R

Item	Title of tool	Past flight manifest								EVA compatibility
		STS-5	STS-6	STS 41-B	STS 41-C	STS 41-G	STS 51-A	STS 51-I	STS 61-B	HR - Highly recommended R - *Recommended* NR - Not recommended
65	Electrical connector and cap, EVA							✓		HR
66	Electrical connector pin straightener				✓			✓		R
67	Electrical connector pin straightener, multisize									R
68	Electrical D-connector installation tool			✓	✓					R
69	Electrical D-connector removal tool			✓	✓					R
70	EMU battery	✓	✓	✓	✓	✓	✓	✓	✓	R
71	EMU lights	✓	✓	✓	✓	✓	✓	✓	✓	R
72	EMU lights battery	✓	✓	✓	✓	✓	✓	✓	✓	R
73	EMU TV			✓	✓					R
74	EMU TV battery			✓	✓					R
75	EMU TV receiver and video processor assembly			✓	✓					R
76	EMU watch	✓	✓	✓	✓	✓	✓	✓	✓	R
77	Equipment tether, adjustable									R
78	External tank door latch tool									R
79	Extravehicular mobility unit	✓	✓	✓	✓	✓	✓	✓	✓	N/A
80	Fastener, 1/4-turn									R
81	Flashlight			✓		✓	✓	✓		R
82	Flight support system locker				✓					R
83	Fluid connector, EVA									HR
84	Force measurement tool			✓						R
85	Forceps	✓	✓	✓	✓	✓	✓	✓	✓	R

Item	Title of tool	Past flight manifest								EVA compatibility
		STS-5	STS-6	STS 41-B	STS 41-C	STS 41-G	STS 51-A	STS 51-I	STS 61-B	HR - Highly recommended R - Recommended NR - Not recommended
86	Fuse transfer container									R
87	Hammer	✓	✓	✓	✓	✓	✓	✓	✓	R
88	Handrail, EVA	✓	✓	✓	✓	✓	✓	✓	✓	HR
89	Harpoon, EASE truss node								✓	R
90	Harpoon, Space Station Freedom truss node									R
91	Hook, french	✓	✓	✓	✓	✓	✓	✓	✓	R
92	Hook, truss strut									R
93	Hook, universal tether	✓	✓	✓	✓	✓	✓	✓	✓	HR
94	Hydrazine analyzer					✓	✓	✓		R
95	Hydrazine ball valve housing			✓		✓				NR
96	Hydrazine brush			✓		✓				R
97	Hydrazine cap retainer assembly			✓		✓				NR
98	Hydrazine detector			✓		✓				R
99	Hydrazine dust cap remover			✓		✓				NR
100	Hydrazine multipurpose tool			✓		✓				NR
101	Hydrazine nut retainer assembly			✓		✓				NR
102	Hydrazine removal canister					✓	✓	✓		N/A
103	Hydrazine retrieval tool			✓		✓				NR
104	Hydrazine right angle clipper			✓		✓				R
105	Hydrazine safety wire clipper			✓		✓				R
106	Hydrazine seal verification tool			✓		✓				NR

Item	Title of tool	Past flight manifest								EVA compatibility
		STS-5	STS-6	STS 41-B	STS 41-C	STS 41-G	STS 51-A	STS 51-I	STS 61-B	HR - Highly recommended R - Recommended NR - Not recommended
107	Hydrazine spanner wrench			✓		✓				NR
108	Hydrazine tool support brace					✓				NR
109	Jettison handle									R
110	Jumper cable				✓					R
111	Knob, EVA									R
112	Latch, 1/4-turn door			✓	✓					R
113	Leasat equipment stowage assembly							✓		R
114	Lever wrench	✓	✓							NR
115	Loop pin extractor	✓	✓	✓	✓	✓	✓	✓	✓	R
116	Magnetic handling aid									R
117	Magnetic panel attachment device									R
118	Manipulator foot restraint			✓	✓		✓	✓	✓	HR
119	Manned maneuvering unit			✓	✓		✓			R
120	Manual aft frame tilt actuator		✓							R
121	Mechanical finger, EVA									R
122	Mini work station	✓	✓	✓	✓	✓	✓	✓	✓	HR
123	MMU 35-mm camera actuator and cable			✓						R
124	MMU 35-mm camera cover			✓						R
125	MMU 35-mm camera mount			✓						R
126	MMU battery			✓	✓		✓			R
127	MMU battery recharge cable			✓	✓		✓			R

Item	Title of tool	Past flight manifest								EVA compatibility
		STS-5	STS-6	STS 41-B	STS 41-C	STS 41-G	STS 51-A	STS 51-I	STS 61-B	HR - Highly recommended R - Recommended NR - Not recommended
128	MMU battery transfer bag			✓	✓		✓			R
129	MMU battery transfer strap			✓	✓		✓			R
130	MMU flight support station			✓	✓		✓			R
131	MMU FSS contingency tool			✓	✓		✓			R
132	MMU thruster cue light extender			✓	✓		✓			R
133	Module servicing tool				✓					R
134	MST manual backup				✓					NR
135	Needle nose pliers	✓	✓	✓	✓	✓	✓	✓	✓	R
136	Number 10 allen wrench extension for 3/8-inch drive			✓	✓		✓			R
137	Number 10 allen wrench, L-handle						✓	✓		NR
138	PAM-D wedge			✓	✓	✓	✓	✓	✓	NR
139	Payload clamp assembly driver									NR
140	Payload clamp assembly torque limited driver									NR
141	Payload interface mechanism			✓	✓		✓			HR
142	Payload interface mechanism adapter				✓					HR
143	Payload retention device	✓	✓	✓	✓	✓	✓	✓	✓	R
144	PFR articulating socket				✓		✓			HR
145	PFR centerline clamp assembly	✓	✓	✓	✓	✓	✓	✓	✓	NR
146	PFR extender									R
147	PFR socket			✓	✓		✓	✓	✓	HR
148	PFR socket (HST)									HR

Item	Title of tool	Past flight manifest								EVA compatibility
		STS-5	STS-6	STS 41-B	STS 41-C	STS 41-G	STS 51-A	STS 51-I	STS 61-B	HR - Highly recommended R - Recommended NR - Not recommended
149	PFR socket, bridge fitting									HR
150	PFR socket, sill longeron									HR
151	PFR work station stanchion							✓		HR
152	Pip pin			✓	✓		✓	✓		HR
153	Portable flood light									R
154	Portable foot restraint	✓	✓	✓	✓	✓	✓	✓	✓	HR
155	Portable foot restraint (HST)									HR
156	Portable ORU handle, large									R
157	Portable ORU handle, small									R
158	Power drive unit disconnect	✓	✓	✓	✓	✓	✓	✓	✓	NR
159	Power package, EVA							✓		HR
160	Power ratchet tool									HR
161	Power tool battery bag, EVA			✓	✓		✓	✓		R
162	Power tool battery, EVA			✓	✓		✓	✓		R
163	Power tool battery, mini									R
164	Power tool, EVA			✓	✓		✓	✓		HR
165	Power tool, EVA (HST)									HR
166	Power tool, mini									HR
167	Power tool, smart									HR
168	Probe	✓	✓	✓	✓	✓	✓	✓	✓	R
169	Provisions stowage assembly					✓	✓	✓	✓	R

Item	Title of tool	Past flight manifest								EVA compatibility
		STS-5	STS-6	STS 41-B	STS 41-C	STS 41-G	STS 51-A	STS 51-I	STS 61-B	HR - Highly recommended R - Recommended NR - Not recommended
170	Pry bar	✓	✓	✓	✓	✓	✓	✓	✓	R
171	Ratchet with 15/16-inch hex socket									R
172	Retaining mechanism, tool									R
173	Retractable tether	✓	✓	✓	✓	✓	✓	✓	✓	HR
174	Right angle drive							✓		R
175	RMS MPM wrench			✓	✓	✓	✓	✓	✓	R
176	RMS PFR attachment device									R
177	RMS rope reel			✓	✓	✓	✓	✓	✓	R
178	RMS shoulder brace release tool			✓	✓	✓	✓	✓	✓	R
179	Safety tether	✓	✓	✓	✓	✓	✓	✓	✓	HR
180	Saw									NR
181	Scissors, EMU	✓	✓	✓	✓	✓	✓	✓	✓	R
182	Scissors, modified				✓		✓	✓		R
183	Screws, EVA captive							✓		HR
184	Shorting plug							✓		R
185	Shrouded flex screwdriver									R
186	Shrouded rigid screwdriver									R
187	Shrouded screwdriver extension for 3/8-inch drive			✓	✓					R
188	Shuttle umbilical retraction system wrench					✓	✓	✓	✓	NR
189	Snatch block			✓	✓	✓	✓	✓	✓	R
190	Spacecraft adapter						✓			R

Item	Title of tool	Past flight manifest								EVA compatibility
		STS-5	STS-6	STS 41-B	STS 41-C	STS 41-G	STS 51-A	STS 51-I	STS 61-B	HR - Highly recommended R - Recommended NR - Not recommended
191	Special equipment stowage assembly			✓						R
192	Spreader assembly							✓		NR
193	Switch, EVA							✓		HR
194	T-handle							✓		R
195	T-handle, electrical connector cap							✓		R
196	Tape caddy, Kapton				✓	✓	✓	✓	✓	NR
197	Telescoping boom		✓							R
198	Tension buckle				✓		✓	✓		R
199	Tether hook, one-handed									R
200	Tether hook, quick attach									R
201	Tether point				✓		✓			HR
202	Thermal mittens	✓	✓	✓	✓	✓	✓	✓	✓	NR
203	Three-point latch tool	✓	✓	✓	✓	✓	✓	✓	✓	NR
204	Three-point latch tool bag	✓	✓	✓	✓	✓	✓	✓	✓	R
205	Tool board			✓	✓		✓	✓	✓	HR
206	Tool board, cushioned									R
207	Tool box (HST)									R
208	Tool caddy	✓	✓	✓	✓	✓	✓	✓	✓	HR
209	Tool caddy, McCaddy and ratchet									R
210	Tool container assembly							✓		R
211	Tool stowage bag						✓			R

Item	Title of tool	Past flight manifest								EVA compatibility
		STS-5	STS-6	STS 41-B	STS 41-C	STS 41-G	STS 51-A	STS 51-I	STS 61-B	HR - Highly recommended R - Recommended NR - Not recommended
212	Torq-Set tip extension							✓		NR
213	Torq-Set tip extension (HST)									NR
214	Torque limiter, multisetting									R
215	Torque multiplier									NR
216	Torque recorder with 7/16-inch hex socket	✓	✓							R
217	Torque wrench						✓			R
218	Transfer bag							✓		R
219	Trash bag, large			✓	✓		✓	✓		R
220	Trash bag, small	✓	✓	✓	✓	✓	✓	✓	✓	R
221	Trunnion pin attachment device			✓	✓					NR
222	Tube cutter	✓	✓	✓	✓	✓	✓	✓	✓	R
223	Velcro caddy			✓	✓	✓	✓	✓	✓	R
224	Vise-grip pliers	✓	✓	✓	✓	✓	✓	✓	✓	NR
225	Vise-grip pliers, one-handed									R
226	Waist tether	✓	✓	✓	✓	✓	✓	✓	✓	HR
227	Winch, EVA	✓	✓	✓	✓	✓	✓	✓	✓	R
228	Wrist mirror	✓	✓	✓	✓	✓	✓	✓	✓	R
229	Wrist tether	✓	✓	✓	✓	✓	✓	✓	✓	HR
230	Wrist tether, adjustable	✓	✓	✓	✓	✓	✓	✓	✓	HR

APPENDIX C
EQUIPMENT CLASSIFICATION

This appendix places the catalog hardware into generalized categories by equipment types. It can be used in conjunction with the table of contents to locate an item of interest. The titles of the applicable equipment as listed in the table of contents are shown under each category. The following classifications are used in the index:

Type	Examples
Cutter	Saws, wire cutters, tube cutters, clippers, scissors
Drive	Manual drive ratchets
Electrical	Connectors, pin tools, connector tools, cables, switches
Fluid transfer	Satellite propellant servicing equipment
Lever	Pry bars, bolt pullers, spreaders
Photo/lights	Cameras, TV's, lighting
Power	Batteries, power tools, power packages
Restraint	Equipment tethers, crew tethers, ropes, tape, Velcro
Socket	Allen extensions, hex sockets, screwdriver extensions
Stowage	Lockers, bags, containers
Work station	Foot restraints, foot restraint sockets, stanchions
Wrench	Pliers, open-end wrenches, ratcheting wrenches
Other	MMU, EMU, EVA docking adapters, any miscellaneous items

Cutter

Antenna cutter
Cable cutter
Cable cutter, compound
Cable cutter, large
Diagonal cutters
Hydrazine right angle clipper
Hydrazine safety wire clipper
Saw
Scissors, EMU
Scissors, modified
Tube cutter

Drive

1/2-inch drive ratchet
3/8-inch drive McTether ratchet
3/8-inch drive ratchet
3/8-inch drive ratchet (SAL)
3/8-inch drive ratchet with 7/16-inch hex socket
3/8-inch drive ratchet with 7/16-inch hex socket extension
3/8-inch drive ratchet, EVA
3/8-inch drive ratchet, EVA with 7/16-inch hex socket
MMU FSS contingency tool assembly
MST manual backup
Payload clamp assembly driver
Payload clamp assembly torque limited driver
Ratchet with 15/16-inch hex socket
Torque recorder with 7/16-inch hex socket
Torque wrench

Electrical

Circular connector tool
Circular connector tool
Coax connector tool
Coax connector tool, round
D-connector demate tool
D-connector mate tool
Electrical circular connector tool
Electrical connector and cap, EVA
Electrical connector pin straightener
Electrical connector pin straightener, multisize
Electrical D-connector installation tool
Electrical D-connector removal tool
Jumper cable
MMU battery recharge cable
Shorting plug
Switch, EVA

Fluid transfer

Coupling, Helium II Resupply
Fluid connector, EVA
Hydrazine ball valve housing
Hydrazine cap retainer assembly
Hydrazine dust cap remover
Hydrazine multipurpose tool
Hydrazine nut retainer assembly
Hydrazine removal canister
Hydrazine retrieval tool
Hydrazine seal verification tool
Hydrazine tool support brace

Lever

Bolt puller
Loop pin extractor
PAM-D wedge
Power drive unit disconnect
Probe
Pry bar
RMS shoulder brace release tool
Spreader assembly

Photo/lights

35-mm camera
35-mm camera cover
35-mm camera mount
EMU lights
EMU lights battery
EMU TV
EMU TV battery
EMU TV receiver and video processor assembly
Flashlight
MMU 35-mm camera actuator and cable
MMU 35-mm camera cover
MMU 35-mm camera mount
Portable flood light

Power

EMU battery
MMU battery
Module servicing tool
Power package, EVA
Power ratchet tool
Power tool battery, EVA

Power (cont.)

Power tool battery, mini
Power tool, EVA
Power tool, EVA (HST)
Power tool, mini
Power tool, smart

Restraint

Bolt, EVA hex-head
Drop-proof tether
Equipment tether, adjustable
Handrail, EVA
Harpoon, EASE truss node
Harpoon, Space Station Freedom truss node
Hook, french
Hook, truss strut
Hook, universal tether
Jettison handle
Knob, EVA
Latch, 1/4-turn door
Mini work station
MMU battery transfer strap
Payload interface mechanism
Payload interface mechanism adapter
Payload retention device
Pip pin
Retaining mechanism, tool
Retractable tether
RMS rope reel
Safety tether
Screws, EVA captive
Snatch block
Tape caddy, Kapton
Telescoping boom
Tensioning buckle
Tether hook, EVA, one-handed
Tether hook, quick attach
Tether point
Tool board
Tool caddy
Tool caddy, McCaddy and ratchet
Velcro caddy
Waist tether
Winch, EVA
Wrist tether
Wrist tether, adjustable

Socket

1/2-inch allen wrench extension for 3/8-inch drive
1/4-inch allen wrench extension for 3/8-inch drive

Socket (cont.)

1/4-inch allen wrench extension for 3/8-inch drive (IPS)
1/4-inch drill extension for 3/8-inch drive
5/16-inch hex socket for 3/8-inch drive
5/16-inch hex socket for 3/8-inch drive (HST)
7/16-inch hex socket extension for 3/8-inch drive
7/16-inch hex socket extension for 3/8-inch drive (HST)
7/16-inch hex socket for 3/8-inch drive (HST)
Number 10 allen wrench extension for 3/8-inch drive
Right angle drive
Shrouded flex screwdriver
Shrouded rigid screwdriver
Shrouded screwdriver extension for 3/8-inch drive
Torq-Set tip extension
Torq-Set tip extension (HST)
Torque limiter, multisetting

Stowage

Airlock stowage bag
Bag, EVA
Bar stowage assembly
Cargo bay stowage assembly
Centerline latch tool bag
Flight support system locker
Fuse transfer container
Leasat equipment stowage assembly
MMU battery transfer bag
MMU flight support station
Power ratchet tool transfer bag
Power tool battery bag, EVA
Provisions stowage assembly
Special equipment stowage assembly
Three-point latch tool bag
Tool box (HST)
Tool container assembly
Tool stowage bag
Transfer bag
Trash bag, large
Trash bag, small

Work station

Manipulator foot restraint
PFR articulating socket
PFR centerline clamp assembly
PFR extender
PFR socket

Work station (cont.)

PFR socket (HST)
PFR socket, bridge fitting
PFR socket, sill longeron
PFR work station stanchion
Portable foot restraint
Portable foot restraint (HST)
RMS PFR attachment device
Telescoping boom

Wrench

1/2-inch open end wrench
1/2-inch ratcheting box end wrench
1/4-inch crow's foot wrench
15/16-inch wrench with cheater bar
7/16-inch and 1/2-inch box end wrench
7/16-inch open end wrench
7/16-inch ratcheting open end wrench
Adjustable wrench
Contingency strut wrench
Forceps
Hydrazine spanner wrench
Lever wrench
Needle nose pliers
RMS MPM wrench
Shuttle umbilical retraction system wrench
Vise-grip pliers
Vise-grip pliers, one-handed

Other

Airlock
Antenna bridge structure
Apogee kick motor capture device
Apogee kick motor nozzle cover
Bar, capture
Bar, grapple
Bar, handling
Bar, spin-up
Carryout bracket
Centerline latch bypass tool
Cuff checklist
Door stay, adjustable, SSM
Door stay, OTA
Door support bracket
Drive unit preload tool
EMU watch
External tank door latch tool

Other (cont.)

Extravehicular mobility unit
Force measurement tool
Hammer
Hydrazine analyzer
Hydrazine brush
Hydrazine detector
Magnetic handling aid
Magnetic panel attachment device
Manned maneuvering unit
Manual aft frame tilt actuator
Mechanical finger, EVA
MMU thruster cue light extender
Number 10 allen wrench, L-handle
Portable ORU handle, large
Portable ORU handle, small
Spacecraft adapter
T-handle
T-handle, electrical connector cap
Thermal mittens
Three-point latch tool
Torque multiplier
Trunnion pin attachment device
Wrist mirror

APPENDIX D
REFERENCES

Cargo Systems Manual: SMRM, STS-13. JSC-19034, Oct. 1983.

CONT OPS 2102, Contingency Operations Training Workbook. TD88-054, Aug. 1988.

Description and Design Requirements-EVA, NSTS 07700, vol. XIV, appendix 7, Mar. 1988.

EVA Annex, EASE/ACCESS, rev A. JSC-18436, annex 11, Jan. 1985.

EVA Annex, HS 376 Retrieval Mission. JSC-18443, annex 11, Nov. 1984.

EVA Annex, Inertial Upper Stage (Generic). JSC-18490, annex 11, Nov. 1984.

EVA Annex, Office of Applications and Space Technology - 1. JSC-14602, annex 11, June 1984.

EVA Annex, Orbital Refueling System. JSC-18417, annex 11, Sept. 1984.

EVA Annex, Solar Maximum Repair Mission. JSC-14082, annex 11, Mar. 1984.

EVA Annex, Spacelab Scientific Airlock (Generic). JSC-14008, annex 11, Mar. 1984.

EVA Annex, SURS Umbilical (Generic). JSC 18483, annex 11, Oct. 1984.

EVA Annex, Spacelab 2, Basic. JSC-14023, annex 11, June 1985.

EVA Annex, Spartan 1, Basic. JSC-14058, annex 11, Apr. 1985.

Hubble Space Telescope (HST) EVA Tools Critical Design Review, ILC Space Systems, Dec. 1987.

Manned Spacecraft In-flight Tools Source Document. STS 81-0716, Jan. 1982.

Man/Systems Integration Standards (MSIS), NASA-STD-3000, vol. 1, Mar. 1987.

MMU Systems Data Book, vols. I and II, MMU-SE-17, rev B. NAS-9-17018, July 1985.

MMU User's Guide, MMU-SE-17-46, rev A. NAS-9-17018, July 1985.

Servicing Equipment Catalog, JSC-22976, June 1988.

Study of EVA Operations Associated with Satellite Services. Apr. 1982.

APPENDIX E
ACRONYMS

ABS	antenna bridge structure
ACD	apogee kick motor capture device
AKM	apogee kick motor
APC	adaptive payload carrier
CBSA	cargo bay stowage assembly
CTSD	Crew and Thermal Systems Division
DCM	display and control module
DDL	door drive linkage
EMU	extravehicular mobility unit
EPP	EVA power package
EVA	extravehicular activity
FSS	flight support station flight support system
GAS	get-away special
GRO	Gamma Ray Observatory
HST	Hubble Space Telescope hydrazine servicing tool
IPS	instrument pointing system
IUS	inertial upper stage
LESA	Leasat equipment stowage assembly
LSM	Leasat salvage mission
MEB	main electronics box
MFR	manipulator foot restraint
MMS	multimission modular spacecraft
MMU	manned maneuvering unit
MPESS	mission peculiar equipment support subsystem
MPM	manipulator positioning mechanism
MST	module servicing tool
MWS	mini work station
N/A	not applicable
ORS	orbital refueling system
ORU	orbital replaceable unit
PAM	payload assist module
PCA	payload clamp assembly
PDU	power drive unit
PFR	portable foot restraint

PIM	payload interface mechanism
PRD	payload retention device
PRT	power ratchet tool
PSA	provisions stowage assembly
REM	remote engagement mechanism
RMS	remote manipulator system
SAL	scientific airlock
SAS	spacecraft adapter structure
SESA	special equipment stowage assembly
SMM	Solar Maximum mission
SMRM	Solar Maximum repair mission
SPAS	Shuttle pallet satellite
SRM	satellite retrieval mission
STS	Space Transportation System
SURS	Shuttle umbilical retraction system
TCA	tool container assembly
TPAD	trunnion pin attachment device
VPU	video processing unit

*U.S.GOVERNMENT PRINTING OFFICE:1989-661-008/00177